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Coal Combustion Residue Impoundment
Round 9 - Dam Assessment Report

Cliffside Steam Station
Ash Basin Dikes
Duke Energy Corporation
Mooresboro, North Carolina

Prepared for:

United States Environmental Protection Agency
Office of Resource Conservation and Recovery

Prepared by:

Dewberry & Davis, LLC
Fairfax, Virginia

Under Contract Number: EP-09W001727
April 2011

INTRODUCTION, SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The release of over five million cubic yards of coal combustion waste from the Tennessee Valley Authority's Kingston, Tennessee facility in December 2008 flooded more than 300 acres of land, damaging homes and property. In response the U.S. EPA is assessing the stability and functionality of the coal combustion ash impoundments and other management units across the country and, as necessary, identifying any needed corrective measures.

This assessment of the stability and functionality of the Cliffside Steam Station Ash Basin Dikes is based on a review of available documents and on the site assessment conducted by Dewberry personnel on February 23, 2011. We found the supporting technical documentation adequate (Section 1.1.3). As detailed in Section 1.2.5, there are two recommendations based on field observations that may help to maintain a safe and trouble-free operation.

In summary, the Cliffside Steam Station Ash Basin Dikes are SATISFACTORY for continued safe and reliable operation, with no recognized existing or potential management unity safety deficiencies.

PURPOSE AND SCOPE

The U.S. Environmental Protection Agency (EPA) is embarking on an initiative to investigate the potential for catastrophic failure of Coal Combustion Surface Impoundments (i.e., management unit) from occurring at electric utilities in an effort to protect lives and property from the consequences of a dam failure or the improper release of impounded slurry. The EPA initiative is intended to identify conditions that may adversely affect the structural stability and functionality of a management unit and its appurtenant structures (if present); to note the extent of deterioration (if present), status of maintenance and/or a need for immediate repair; to evaluate conformity with current design and construction practices; and to determine the hazard potential classification for units not currently classified by the management unit owner or by a state or federal agency. The initiative will address management units that are classified as having a Less-than-Low, Low, Significant or High Hazard Potential ranking. (For Classification, see pp. 3-8 of the 2004 Federal Guidelines for Dam Safety).

In early 2009, the EPA sent its first wave of letters to coal-fired electric utilities seeking information on the safety of surface impoundments and similar facilities that receive liquid-borne material that store or dispose of coal combustion residue. This letter was issued under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104(e), to assist the Agency in assessing the structural stability and functionality of such management units, including which facilities should be visited to perform a safety assessment of the berms, dikes, and dams used in the construction of these impoundments.

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EPA requested that utility companies identify all management units including surface impoundments or similar diked or bermed management units or management units designated as landfills that receive liquid-borne material used for the storage or disposal of residuals or by-products from the combustion of coal, including, but not limited to, fly ash, bottom ash, boiler slag, or flue gas emission control residuals. Utility companies provided information on the size, design, age and the amount of material placed in the units. The EPA used the information received from the utilities to determine preliminarily which management units had or potentially could have High Hazard Potential ranking.

The purpose of this report is to evaluate the condition and potential of residue release from management units that have or have not been rated for hazard potential classification. This evaluation included a site visit. Prior to conducting the site visit, a two-person team reviewed the information submitted to EPA, reviewed any relevant publicly available information from state or federal agencies regarding the unit hazard potential classification (if any) and accepted information provided via telephone communication with the management unit owner.

Factors considered in determining the hazard potential classification of the management units(s) included the age and size of the impoundment, the quantity of coal combustion residuals or by-products that were stored or disposed of in these impoundments, its past operating history, and its geographic location relative to down gradient population centers and/or sensitive environmental systems.

This report presents the opinion of the assessment team as to the potential of catastrophic failure and reports on the condition of the management unit(s).

LIMITATIONS

The assessment of dam safety reported herein is based on field observations and review of readily available information provided by the owner/operator of the subject coal combustion residue management unit(s). Qualified Dewberry engineering personnel performed the field observations and review and made the assessment in conformance with the required scope of work and in accordance with reasonable and acceptable engineering practices. No other warranty, either written or implied, is made with regard to our assessment of dam safety.

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1.0 CONCLUSIONS AND RECOMMENDATIONS

1.1 CONCLUSIONS

Conclusions are based on visual observations from a one-day site visit, February 23, 2011, and review of technical documentation provided by Duke Power Company.

1.1.1 Conclusions Regarding the Structural Soundness of the Management Unit(s)

The dike embankments and spillway appear to be structurally sound based on a review of the engineering data provided by the owner's technical staff and Dewberry engineers' observations during the site visit.

1.1.2 Conclusions Regarding the Hydrologic/Hydraulic Safety of the Management Unit(s)

Adequate capacity and freeboard to safely pass the design storm (full Probable Maximum Precipitation (PMP)) has not been demonstrated. Hydrologic and hydraulic analyses provided to Dewberry indicate there is adequate impoundment capacity to contain the ½ PMP design storm without overtopping the dikes. (Appendix A: Doc 01 – 2007 Five-Year Inspection Report).

1.1.3 Conclusions Regarding the Adequacy of Supporting Technical Documentation

Supporting documentation reviewed by Dewberry is inadequate. Although documentation was provided for the hydrologic/hydraulic safety analysis, the PMP design storm was not assessed. Remaining supporting technical documentation is adequate. Engineering documentation reviewed is referenced in Appendix A.

1.1.4 Conclusions Regarding the Description of the Management Unit(s)

The description of the management unit provided by the owner was an accurate representation of what Dewberry observed in the field.

1.1.5 Conclusions Regarding the Field Observations

The visible parts of the embankment dikes and outlet structure were observed to have no signs of overstress, significant settlement, shear failure, or other signs of significant instability although widespread seepage was observed along the toe of the upstream dike which needs to continue to be monitored. There are no apparent indications of unsafe conditions or conditions needing remedial action.

1.1.6 Conclusions Regarding the Adequacy of Maintenance and Methods of Operation

The current maintenance and methods of operation appear to be adequate for the ash management unit. There was no evidence of significant embankment repairs or prior releases observed during the field inspection. However there were minor ruts from erosion along the upstream dike, left abutment crest.

1.1.7 Conclusions Regarding the Adequacy of the Surveillance and Monitoring Program

The surveillance program appears to be adequate. The management unit dikes are instrumented. Multiple piezometers and observation wells have been installed as instrumentation. However, widespread seepage at the toe of the upstream dike and seepage at the toe of the downstream dike need to be monitored and recorded. If discoloration or changes in the flow are observed, then an action plan should be developed

1.1.8 Classification Regarding Suitability for Continued Safe and Reliable Operation

The facility is SATISFACTORY for continued safe and reliable operation. No existing or potential management unit safety deficiencies are recognized. Acceptable performance is expected under all applicable loading conditions (static, hydrologic, seismic) in accordance with the applicable criteria.

1.2 RECOMMENDATIONS

1.2.1 Recommendations Regarding the Hydrologic/Hydraulic Safety

Perform hydrologic/hydraulic analysis to document adequate freeboard exists to pass the PMP event.

1.2.2 Recommendations Regarding the Field Observations

Continue to monitor seepage along the toe of both embankments.

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1.2.3 Recommendations Regarding the Maintenance and Methods of Operation

Remediate minor rutting along upstream dike, left abutment crest

1.3 PARTICIPANTS AND ACKNOWLEDGEMENT

1.3.1 List of Participants

Steve Hodges, Duke
Joshua Moore, Duke
Alex Papp, Duke
Henry Taylor, Duke
Tim Russell, Duke
Ed Sullivan, Duke
Don Price, NCDENR-DWQ-ARO
Andy Schneider, NCDENR
Tamera Eplin, NCDENR-LQ
Scott Harrell, NCDENR-LQ
Ryan Kormanik, NCDENR-LQ
Larry Frost, NCDENR-WM
Bill Wagner, NCDENR-DWM
Craig Dufficy, US EPA
Justin Story, Dewberry
Frederic Shmurak, Dewberry

1.3.2 Acknowledgement and Signature

We acknowledge that the management unit referenced herein has been assessed on February 23, 2011.

________________________ ________________________

Frederic Shmurak, P.E. Justin Story, E.I.

2.0 DESCRIPTION OF THE COAL COMBUSTION RESIDUE MANAGEMENT UNIT(S)

2.1 LOCATION AND GENERAL DESCRIPTION

The Cliffside Steam Station is situated on the Cleveland/Rutherford County Line in Mooresboro, North Carolina. The site is just to the south of the Broad River and is approximately 55 miles west of Charlotte, NC. The nearest downstream town is Gaffney, South Carolina and is approximately 12 miles away. Figure 2.1a depicts a vicinity map around the Cliffside Steam Station while Figure 2.1b depicts an aerial view of the Cliffside Station. Table 2.1 provides the physical dimensions of the ash basin dikes.

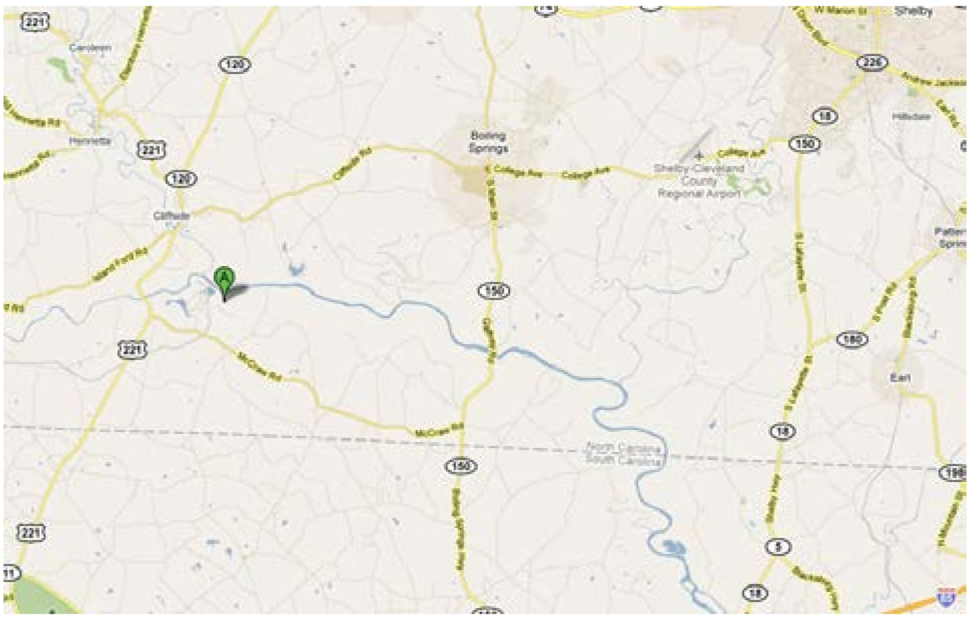

Figure 2.1 a: Cliffside Steam Station Vicinity Map

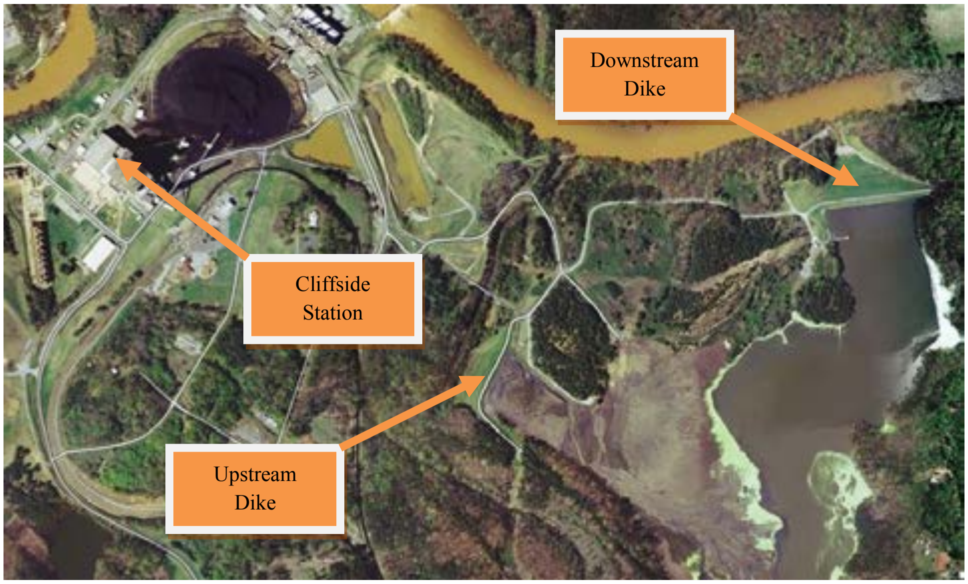

Figure 2.1 b: Cliffside Steam Station Aerial View

Table 2.1: Summary of Dam Dimensions and Size		
	Upstream Embankment	**Downstream Embankment**
Dam Height (ft)	60	120
Crest Width (ft)	15	15
Length (ft)	890	876
Side Slopes (upstream) H:V	2.5:1	2.5:1/2.1
Side Slopes (downstream) H:V	2.5:1/2:1	2.5:1

2.2 COAL COMBUSTION RESIDUE HANDLING

2.2.1 Fly Ash

Fly ash is collected at the base of the stack by an electrostatic precipitator. The collected ash is stored in hoppers and conveyed pneumatically to a silo (see photo below). From the silo it is conveyed hydraulically in a pipe to the Active Ash Pond. The discharge into the ash pond is continuous.

Fly Ash Hoppers

Fly Ash Silo

2.2.2 Bottom Ash

Bottom ash is collected from the furnace and conveyed through the same pipe as the fly ash into the Active Ash Pond.

Bottom Ash Collection

2.2.3 Boiler Slag

Boiler slag is collected from the boiler and is sluiced into the same pipe that conveys fly and bottom ash into the Active Ash Pond.

Boiler – Point of Boiler Slag Discharge

2.2.4 Flue Gas Desulfurization Sludge

The Cliffside Steam Station has a flue gas desulfurization unit. Residuals from that process are, at times, transported by pipeline to the ash pond; or may be transported out by truck (i.e. gypsum byproduct).

2.3 SIZE AND HAZARD CLASSIFICATION

The ash pond is a cross-valley system impounded by two earthen embankment dikes. One dike is labeled as the downstream dike (State ID # CLEVE-049) which is closest to the NPDES permitted outfall and the other is the upstream dike (State ID # CLEVE-050).

Table 2.3a: USACE ER 1110-2-106
Size Classification

	Downstream Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

Table 2.3a: USACE ER 1110-2-106
Size Classification

	Upstream Impoundment	
Category	**Storage (Ac-ft)**	**Height (ft)**
Small	50 and < 1,000	25 and < 40
Intermediate	1,000 and < 50,000	40 and < 100
Large	> 50,000	> 100

A Hazard Classification of Low has been assigned based on North Carolina Utilities Commission Criteria. Based on observations, a classification of **Significant** appears to be appropriate. Per the Federal Guidelines for Dam Safety dated April 2004, a Significant Hazard Potential classification applies to those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Losses are principally limited to the owner's property.

Table 2.3b: FEMA Federal Guidelines for Dam Safety Hazard Classification		
	Loss of Human Life	**Economic, Environmental, Lifeline Losses**
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable. One or more expected	Yes (but not necessary for classification)

Considering the low probability of loss of life should the fly ash dam system fail, a Federal Hazard Classification of **Significant** is appropriate for this size facility.

2.4 AMOUNT AND TYPE OF RESIDUALS CURRENTLY CONTAINED IN THE UNIT(S) AND MAXIMUM CAPACITY

The ash pond permanently contains fly ash, bottom ash, pyrites, flue gas emission control residuals, and boiler slag. Pond wastewater is from water treatment; boiler blowdown; floor, laboratory and equipment cleaning drains; cooling tower blowdown; boiler chemical cleaning wastes; storm water runoff; coal pile runoff; fire protection; and mill rejects.

Table 2.4: Maximum Capacity of Unit	
Cliffside Ash Pond	
Surface Area (acre)	84
Current Storage Capacity (cubic yards)	1,621,400*
Current Storage Capacity (acre-feet)	1,005*
Total Storage Capacity (cubic yards)	8,107,000
Total Storage Capacity (acre-feet)	5,025
Crest Elevation (feet)	775 (lowest)
Normal Pond Level (feet)	765

*Based on an estimate that the ash pond was 80% full in January 2009 (Appendix A: Doc 02: Response to EPA)

2.5 PRINCIPAL PROJECT STRUCTURES

2.5.1 Earth Embankment

The original material of the embankment is assumed to be native soils from nearby borrow pits.

2.5.2 Outlet Structures

A drainage tower that discharges through a 42-inch diameter reinforced concrete pipe (RCP) into the Broad River is the main outlet structure.

2.6 CRITICAL INFRASTRUCTURE WITHIN FIVE MILES DOWN GRADIENT

Dewberry attempted to identify critical structures using aerial photography, which might not accurately represent what currently exists down-gradient of the site. No critical infrastructure was found to be downstream of the site.

3.0 SUMMARY OF RELEVANT REPORTS, PERMITS, AND INCIDENTS

Summary of Reports on the Safety of the Management Unit

2007 Five-Year Inspection Report, Cliffside Station Ash Basin Dikes, MACTEC. Dated 1/09/2007. (Appendix A: Doc 01 - 2007 Five-Year Inspection Report)

The report made the following recommendations:

- No further study of hydrologic safety was recommended;
- Grassed slopes of dikes should continue to be reseeded in areas where equipment has disturbed the vegetation, and the existing maintenance program should be continued and upgraded to include regular mowing of the slopes;
- Burrowing animals should be prevented from establishing themselves on the dike slopes and abutments. A maintenance program in which the grass cover is mowed at least twice yearly helps deny cover for the animals;
- Quantitative monitoring of the water level and piezometer water levels should continue on a monthly basis. Data should be updated, recorded and compared to prior analyses;
- Existing vegetation along the swamp area at the downstream toe of the upstream dike should be removed. At least annually, the vegetation in this area should be cut by hand. Construction of surface ditches to drain this area would be helpful in accessing the area for vegetation control;
- The vegetation in the rock rip-rap toe areas of the upstream dike should be removed and then controlled by annual application of herbicide.

Annual and monthly inspections reports are also provided, see Appendix A: Doc 04 and 05 for annual reports and Appendix A: Doc 06 – Jan 2011 Monthly Inspection for an example monthly report.

3.1 SUMMARY OF LOCAL, STATE, AND FEDERAL ENVIRONMENTAL PERMITS

The dam is inspected by NCDENR Dam Safety Program. NCDENR inspection reports can be found in Appendix A: Doc 07 – Cliffside CLEV-049(Downstream Dike) and Doc 08 – Cliffside CLEV-050 (Upstream Dike).

Discharge from the impoundment is regulated by the Federal National Pollutant Discharge Elimination Program (NPDES) and the impoundment has been issued NPDES Permit No. 0005088.

3.2 SUMMARY OF SPILL/RELEASE INCIDENTS

Data reviewed by Dewberry did not indicate any spills, unpermitted releases, or other performance related problems with the dam over the last 10 years.

4.0 SUMMARY OF HISTORY OF CONSTRUCTION AND OPERATION

4.1 SUMMARY OF CONSTRUCTION HISTORY

4.1.1 Original Construction

Design studies, drawings and specifications were made for the ash pond dikes in 1972/73 by Duke Power Company's Design group. Borings at the dike foundations and borrow pits were conducted by Duke's Construction group in the spring and summer of 1973. The construction occurred in two phases, the first of which began in 1974 and was completed in 1975 by Burns and Spangler Construction Company. The second phase consisted of increasing the height of the lower and upper dike which was eventually completed in late 1980.

4.1.2 Significant Changes/Modifications in Design since Original Construction

No documentation of significant changes/modifications in design since original construction was provided.

4.1.3 Significant Repairs/Rehabilitation since Original Construction

No documentation of significant repairs/rehabilitation since original construction was provided.

4.2 SUMMARY OF OPERATIONAL PROCEDURES

4.2.1 Original Operational Procedures

The ash pond was designed and operated for reservoir sedimentation and sediment storage of ash. Plant process waste water, coal combustion waste, coal pile stormwater runoff, and stormwater runoff around the Ash Pond facility are discharged into the reservoir. Inflow water is treated through gravity settling and deposition, and the treated process water and stormwater runoff is discharged through an unregulated type overflow outlet structure.

4.2.2 Significant Changes in Operational Procedures and Original Startup

No documentation was provided describing any significant changes in Operating Procedures.

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4.2.3 Current Operational Procedures

Original operational procedures appear to be effect.

4.2.4 Other Notable Events since Original Startup

No additional information was provided.

5.0 FIELD OBSERVATIONS

5.1 PROJECT OVERVIEW AND SIGNIFICANT FINDINGS

Dewberry personnel Frederic Shmurak, P.E. and Justin Story, E.I. performed a site visit on Wednesday, February 23, 2011, in company with the participants.

The site visit began at 10:00 AM. The weather was a partly cloudy cool day. Photographs were taken of conditions observed. Please refer to the Dam Inspection Checklist in Appendix B. Selected photographs are included here for ease of visual reference. All pictures were taken by Dewberry personnel during the site visit.

The overall assessment of the upstream and downstream dams was that it was in satisfactory condition and no significant findings were noted.

5.2 UPSTREAM DIKE (CLEV-050)

5.2.1 Crest

There was minor rutting along the upstream dike, left abutment crest. Overall, there were no signs of depressions, tension cracking, or other indications of settlement or shear failure and the crest appeared to be in satisfactory condition.

Minor Rutting Along Crest at Left Abutment

5.2.2 Upstream/Inside Slope

No scarps, sloughs, depressions, bulging or other indications of slope instability or signs of erosion were observed. There was an isolated area that had recently been repaired and was covered with an erosion control fabric.

Upstream slope

5.2.3 Downstream/Outside Slope and Toe

Widespread seepage was observed along the toe. No scarps, sloughs, depressions, bulging or other indications of slope instability or signs of erosion were observed.

Widespread seepage along toe

5.2.4 Abutments and Groin Areas

The abutments and groin areas of the dike appear to be in satisfactory condition.

Right Abutment

5.3 DOWNSTREAM DIKE (CLEV-049)

5.3.1 Crest

No scarps, sloughs, depressions, bulging or other indications of slope instability or signs of erosion were observed.

Downstream Dike Crest

5.3.2 Upstream/Inside Slope

No scarps, sloughs, depressions, bulging or other indications of slope instability or signs of erosion were observed.

5.3.3 Downstream/Outside Slope and Toe

No scarps, sloughs, depressions, bulging or other indications of slope instability or signs of erosion were observed. Seepage was observed at the toe of the slope in the vicinity of the internal blanket drain.

Overall View of Downstream Slope

5.3.4 Abutments and Groin Areas

The abutments and groin areas of the dike appear to be in satisfactory condition.

Right Abutment

5.4 OUTLET STRUCTURES

5.4.1 Overflow Structure

The outlet structures were properly discharging flow from the pond and visually appeared to be in good condition.

5.4.2 Outlet Conduit

The visual portion of the outlet conduit was functioning properly with no apparent deterioration.

Outfall into Broad River

5.4.3 Emergency Spillway

No emergency spillway is present.

5.4.4 Low Level Outlet

No low level outlet is present.

6.0 HYDROLOGIC/HYDRAULIC SAFETY

6.1 SUPPORTING TECHNICAL DOCUMENTATION

6.1.1 Flood of Record

No documentation has been provided about the flood of record. It was noted that in October of 2005 a storm equivalent to a 500-year storm event occurred; the embankments were not overtopped.

6.1.2 Inflow Design Flood

According to FEMA Federal Guidelines for Dam Safety, the current practice in the design of dams is to use the Inflow Design Flood (IDF) that is deemed appropriate for the hazard potential of the dam and reservoir, and to design spillways and outlet works that are capable of safely accommodating the flood flow without risking the loss of the dam or endangering areas downstream from the dam to flows greater than the inflow. The recommended IDF or spillway design flood for a significant hazard, large-sized structure (See section 2.2), in accordance with the USACE Recommended Guidelines for Safety Inspection of Dams ER 1110-2-106 criteria is the Probable Maximum Flood (PMF) (See Table 6.1.2).

Table 6.1.2: USACE Hydrologic Evaluation Guidelines Recommended Spillway Design floods

Hazard	Size	Spillway Design Flood
Low	Small	50 to 100-yr frequency
	Intermediate	100-yr to ½ PMF
	Large	½ PMF to PMF
Significant	Small	100-yr to ½ PMF
	Intermediate	½ PMF to PMF
	Large	PMF
High	Small	½ PMF to PMF
	Intermediate	PMF
	Large	PMF

The Probable Maximum Precipitation (PMP) is defined by American Meteorological Society as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year. The National Weather Service (NWS) further states that in consideration of our limited knowledge of the complicated processes and interrelationships in storms, PMP values are identified as estimates. The NWS has published application procedures that can be used with PMP estimates to develop spatial and temporal characteristics of a Probable Maximum Storm (PMS). A PMS thus developed can be used with a precipitation-runoff simulation model to calculate a PMF hydrograph.

The 24 hour, 10-square mile PMP depth is 40 inches. The facility has a contributing drainage area of approximately 258 acres for the ash pond. A 1986 report from Law Engineering states that the ash pond could handle the ½ PMP, 24-hour duration rainfall event. The existing freeboard during the ½ PMP event would be 1.7 feet; however, the design storm of the PMP needs to be evaluated. (Appendix A: Doc 09 – 1986 Five-Year Inspection Report).

6.1.3 Spillway Rating

No spillway rating was provided.

6.1.4 Downstream Flood Analysis

No downstream flood analysis was provided.

6.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Supporting documentation reviewed by Dewberry is inadequate. Although documentation was provided for the hydrologic/hydraulic safety analysis, the PMP design storm was not assessed.

6.3 ASSESSMENT OF HYDROLOGIC/HYDRAULIC SAFETY

Adequate capacity and freeboard to safely pass the design storm has not been demonstrated.

7.0 STRUCTURAL STABILITY

7.1 SUPPORTING TECHNICAL DOCUMENTATION

7.1.1 Stability Analyses and Load Cases Analyzed

A stability analysis summary for the ash pond dated January 8, 2007, by MACTEC, provides information on the stability analysis results and is presented in Section 7.1.4 Factors of Safety and Base Stresses. Steady state (normal) and seismic loading conditions were analyzed. See Appendix A (Doc 01: Five-Year Inspection Report) for the complete summary. This document summarizes slope stability analyses performed in 1983, 1986 and 1997.

7.1.2 Design Parameters and Dam Materials

The MACTEC inspection report includes documentation of the shear strength design properties for the ash pond embankments, Test results showing the strength parameters of the embankments are presented below. The results present generally acceptable values for these types of materials.

Table 4

Soil Properties for Stability Analysis North Embankment

Material	Unit Weight (pcf)	Fiction Angle (degrees)		Cohesion (psf)	
		SCU(1)	SCU(2)	SCU(1)	SCU(2)
Foundation Soil	105	25	25	0	0
Embankment Soil	131	28	34	800	0
Internal Drain	120	30	30	0	0

SCU (1) = Saturated Consolidated Undrained Triaxial Test (R)

SCU (2) = Saturated Consolidated Undrained Triaxial Test Corrected for Pore Pressure (R)

7.1.3 Uplift and/or Phreatic Surface Assumptions

Figure 7.1.3a shows Phreatic Elevations based on historic observations. See Appendix A: Doc 01: Five-Year Inspection Report Table C-1 in Appendix C to see documented historical highs and lows of phreatic elevations. Figure 7.1.3b shows a consistent trend between the ash pond depth and piezometer readings.

Figure 7.1.3a – Phreatic Elevations

	1983	1997	
Location	**Pond at 772**	**Pond 758**	**Pond 772**
Centerline	766	748	766
OW-7	724	730	735*
P-5	664	687	702
OW-8	660	666	676
OW-9	685.5	664	670
Tailwater	655	655	655

*Assumed phreatic line rises to elevation 744 about 14' horizontally upslope from OW-7.

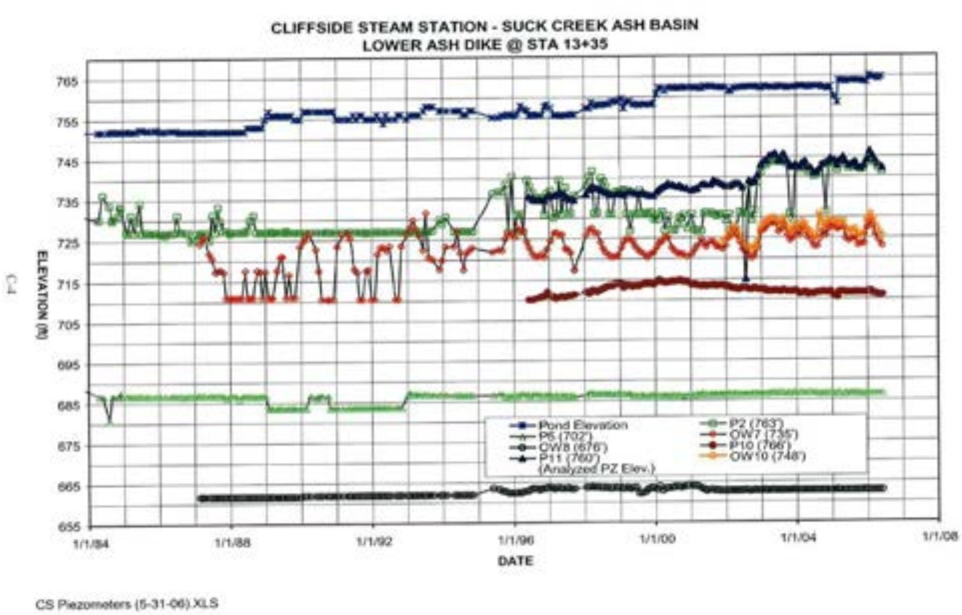

Figure 7.1.3b: Historical Pond Depth VS Piezometer Readings

7.1.4 Factors of Safety and Base Stresses

In the five-year inspection report the downstream dike was considered more critical and a slope stability analysis was provided. The information is summarized below.

Table 7.1.4 Factors of Safety for Cliffside Station Downstream Dike

Loading Condition	Slope	Required Safety Factor (US Army Corps of Engineers)	Cliffside Computed Average Safety Factor
Steady State (772')	Outside	1.5	>1.5
Steady State (772')	Inside	1.5	1.5*
Rapid Drawdown (772' to 755')	Inside	1.25	1.76

*Factors of safety in the range of 1.35 to 1.4 were calculated for shallow (4 to 10' deep) potential failure arcs on the 2:H:1V portion of the inside slope.

7.1.5 Liquefaction Potential

MACTEC's five-year report documents that the embankments are rolled fill construction, wherein the soils were spread in layers and compacted with mechanized equipment. The foundations are not known to contain loose, water deposited sands, which is the most susceptible type of soil for liquefaction by seismic loading.

7.1.6 Critical Geological Conditions

The Cliffside station ash pond geology consists of biotite gneiss and schists with subordinate layers of various metasedimentary rocks. Small masses of granitic rock are coming in this part of the Inner Piedmont. (Appendix A: Doc 01 – 2007 Five-Year Inspection Report).

Based on USGS Seismic-Hazard Maps for the Conterminous United States, the facility is located in an area anticipated to experience a 0.10g acceleration with a 2-percent probability of exceedance in 50-years.

7.2 ADEQUACY OF SUPPORTING TECHNICAL DOCUMENTATION

Structural stability documentation is adequate.

7.3 ASSESSMENT OF STRUCTURAL STABILITY

Overall, the structural stability of the dam appears to be satisfactory.

8.0 ADEQUACY OF MAINTENANCE AND METHODS OF OPERATION

8.1 OPERATING PROCEDURES

Operational procedures are adequate.

8.2 MAINTENANCE OF THE DAM AND PROJECT FACILITIES

The maintenance of the dam and project facilities was adequate, although the following maintenance items need to be addressed:

- Continue monitoring seepage at toe of both embankments
- Repair minor rutting on crest

8.3 ASSESSMENT OF MAINTENANCE AND METHODS OF OPERATIONS

8.3.1 Adequacy of Operating Procedures

Operating procedures appear to be adequate.

8.3.2 Adequacy of Maintenance

Maintenance procedures appear to be adequate.

9.0 ADEQUACY OF SURVEILLANCE AND MONITORING PROGRAM

9.1 SURVEILLANCE PROCEDURES

Monthly Inspections:

Monthly inspections reports were provided by Duke Energy and can be found in Appendix A: Doc 06.

Annual Inspections:

Annual inspections were provided by Duke Energy and can be found in Appendix A: Doc 04 & 05

Five-Year Inspections:

Five-Year inspections reports were provided by Duke Energy and can be found in Appendix A: Doc - 01, 03 & 09.

9.2 INSTRUMENTATION MONITORING

Piezometers and monitoring wells installed are adequate for monitoring the phreatic surface.

9.3 ASSESSMENT OF SURVEILLANCE AND MONITORING PROGRAM

9.3.1 Adequacy of Inspection Program

Based on the data reviewed by Dewberry, including observations during the site visit, the inspection program is adequate.

9.3.2 Adequacy of Instrumentation Monitoring Program

Based on the data reviewed by Dewberry, including observations during the site visit, the instrumentation and surveillance program is adequate.

MACTEC

engineering and constructing a better tomorrow

FILE COPY

January 8, 2007

Mr. Kelly Allison
Duke Energy Corporation
Mail Code: Cliffs
573 Duke Power Road
Mooresboro, North Carolina 28114

Subject: **Five-Year Independent Consultant Inspection**
Cliffside Steam Station
Ash Basin Dikes
Cleveland and Rutherford Counties, North Carolina
Per North Carolina Utilities Commission
MACTEC Project No. 6234-06-3843

Dear Mr. Allison:

MACTEC Engineering and Consulting, Inc. (fka LAW Engineering and Environmental Services, Inc.) is pleased to submit the following report of our independent inspection of the ash dikes at the Cliffside Steam Station. The inspection was performed in accordance with Duke Power Company's Specification No. 5102.00-00-0001 *Specifications for Inspection of Facilities as Required by the North Carolina Utilities Commission*. Our inspection reported herein is the sixth five-year independent consultant inspection of the Cliffside Ash Basin Dikes.

In general, the inspection noted no external, presently visible signs of serious conditions requiring emergency repairs for public safety. Other than routine maintenance, no major repairs appear warranted at this time.

We appreciate the opportunity to provide our professional services to you on this project. Please let us know if you have any questions.

Sincerely,

MACTEC ENGINEERING AND CONSULTING, INC.

Mel Y. Browning

Mel Y. Browning, P.E.
Principal Engineer
Registered, NC 8696

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MYB/CES:cvh

Attachments

FIVE-YEAR INDEPENDENT CONSULTANT INSPECTION
CLIFFSIDE STEAM STATION
ASH BASIN DIKES
CLEVELAND AND RUTHERFORD COUNTIES, NORTH CAROLINA

Prepared for:

Duke Energy Corporation
Charlotte, North Carolina

by:

MACTEC Engineering and Consulting, Inc.
Charlotte, North Carolina

January 8, 2007
MACTEC Project No. 6234-06-3843

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1. INTRODUCTION

1.1 GENERAL

This report presents the results of the sixth independent consultant inspection of the ash basin dikes at the Cliffside Steam Station. The independent inspection is performed at five-year intervals as required by the North Carolina Utilities Commission (NCUC) for facilities operated by Duke Energy Corporation in North Carolina and not licensed by the Federal Energy Regulatory Commission (FERC) and not covered by the North Carolina Dam Safety Law of 1967.

The previous independent inspections were performed in 1981, 1986, 1991, 1996 and 2001 by LAW. The results of those inspections were presented in reports dated October 12, 1981 (LAW Job No. CH 4581), July 10, 1986 (LAW Job No. CHW 5475) October 3, 1991 (LAW Job 222-07255-01), April 24, 1998 (LAW Project 30100-6-2037) and December 10, 2001 (LAW Project 30100-1-0948).

In this current report, emphasis is placed on noting the development of any new conditions or changes in old, previously reported conditions. The previously reported conditions are recounted only where there is a change or where it is of particular interest or of use in describing the overall condition of a specific project structure.

Photographs are used to illustrate general conditions of project structures in overall views and specific conditions in close-up views.

1.2 PURPOSE AND SCOPE

The purpose of this dike safety inspection and report is to identify, within the limitations of surficial field inspection and office review of available data, records and operating history, any actual or potential deficiencies, whether in the condition of the project works or in the quality or adequacy of project maintenance, surveillance, or methods of operation, that might endanger public safety. The objective is to recommend immediate action for public protection where necessary, further studies and analyses where required, and acceptance of the present condition of the dike if the engineering data and inspections so justify.

A review was made of the previously described reports on the safety of the ash basin dikes. A detailed systematic visual inspection of the project works was performed. A relatively detailed photographic record was made of the visible conditions of the principal project works. Review was made of all available relevant data concerning the stability and operational adequacy of the project works. Based upon results of the above work, an engineering opinion is given of the general condition and adequacy of the dikes, as well as assessment of the quality and adequacy of maintenance, surveillance, and methods of project operation for the protection of public safety.

The purpose and scope of this inspection and report are consistent with that outlined in Duke Power Company's Specification No. CSS-5102.00-00-0001, *Specifications for Inspection of Facilities as Required by the North Carolina Utilities Commission* dated March 6, 1991.

2. PROJECT INFORMATION

2.1 LOCATION, GENERAL DESCRIPTION AND RELEVANT HISTORICAL INFORMATION

The Cliffside Steam Station is located on the Broad River approximately 55 miles west of Charlotte and about 1.5 miles south of the small town of Cliffside, North Carolina. The power plant is situated primarily on the south side of the Broad River and straddles the Cleveland/Rutherford County Line. The Units 1-4 ash basin and the Suck Creek ash basin lie southeast of the Units 1-4 powerhouse in Cleveland County; the Unit 5 ash basin lies southwest of the Unit 5 powerhouse in Rutherford County. The project location is shown on Figures 1 and 2.

The facilities of concern in this inspection are the earthfill dikes which impound the ash basins, and the outlets for the basins. The Suck Creek ash basin is the only basin that is currently being used for disposal of ash. The Units 1-4 ash basin and the Unit 5 ash basin have both been retired, except that part of the Units 1-4 basin area is being used as a holding pond for yard drainage from all the units. There also is a small dredge spoil pond within the Units 1-4 basin. A dredge that periodically removes sediment from the plant intake structure on the river pumps the spoil material into the dredge spoil pond. The dredge spoil pond and the yard drainage pond are interconnected with a culvert. Water that accumulates in the yard drainage pond is pumped to the Suck Creek ash basin.

The Units 1-4 ash basin dike is an L-shaped earthfill embankment with an overall length of about 1480 feet along the crest. The dike was designed to have a 15-ft wide crest at elevation 706 ft-MSL. Maximum height of the dike is about 38 ft above the outside (dowostream) toe. Design drawings called for a 2.5H:1V inside (upstream) slope and a 2H:1V outside slope to elevation 682 ft, then 2.5H:1V slope below 682 ft to the toe of the slope.

The outlet for the Units 1-4 ash basin is a reinforced concrete drainage tower with bottom discharge into a 30-inch diameter corrugated metal pipe (CMP) which extends approximately 180 ft (horizontally) through the base of the embankment at a skewed section located near the east end of the dike.

The Unit 5 ash basin dikes are earthfill embankments, including a main dike, a saddle dike and an access road dike. The main dike and saddle dike are the principal embankments which formed the ash basin. The dikes were designed to have 20-ft wide crest at elevation 767 ft-MSL. The main dike is about 1460 ft long at the crest and has a maximum height of about 97 ft above the toe of the outside (downstream) slope; the saddle dike is approximately 590 ft long at the crest and has a maximum height of about 42 ft above the toe of the outside slope (57 ft above the inside slope toe). Design drawings called for 2.5H:1V inside slopes, a 2.8H:1V outside slope at the main dike and a 2.7H:1V outside slope at the saddle dike.

The outlet for the Unit 5 ash basin is a reinforced concrete drainage tower with bottom discharge into a 60-inch diameter reinforced concrete pipe (RCP) which extends approximately 500 ft (horizontally) through the left abutment of the main dike.

The Suck Creek ash basin was formed by construction of two earthfill dikes across Suck Creek, bracketing a 5600-ft long meandering reach of the natural stream valley for ash storage. At the upstream dike, the creek was diverted through a canal to the Broad River.

The downstream dike, located just upstream of the original confluence of Suck Creek with the Broad River, is 876 ft long. The upstream dike is 890 ft long. Both dikes were designed to have 15-ft wide crests at elevation 775 ft-MSL. Maximum height of the downstream dike is about 120 ft above the toe of the outside slope; that of the upstream dike is about 60 ft above the outside slope toe and 65 ft above the inside slope toe.

The downstream dike was designed to have a final inside slope of 2.5H:1V from the crest down to a 15-ft wide berm at elevation 737 ft-MSL, 2H:1V slope below this berm to a lower, 50-ft wide berm at 675 ft-MSL; then 2H:1V slope down to prepared foundation grade. The final outside slope was designed to be 2.5H:1V with 2 berms: one 15-ft wide at elevation 725 ft-MSL and another 20 ft wide at elevation 680 ft-MSL. The 2.5H:1V slope below the lower berm has a cover of riprap designed to be 2.5 ft thick and bedded on a 1-ft thick crushed stone layer. Beyond the toe of the outside slope there is a channel leading to the river. The banks of this channel are protected with riprap.

The upstream dike was designed to have a 2.5H:1V inside slope and 2.5H:1V outside slope down to a berm a elevation 730 ft-MSL; then 2H:1V slope below the berm. The outside slope (and berm) below elevation 735 ft were designed to have a riprap cover.

The outlet for the Suck Creek ash basin is a reinforced concrete drainage tower with bottom discharge into a 42-inch diameter RCP which extends approximately 700 ft (horizontally) beneath the downstream dike at its left (west) abutment.

Plan and section views of the dikes are shown on Figures 3 through 8 in Appendix A.

A relatively detailed account of historical information on the design, construction, operation, instrumentation monitoring and previous inspections of the ash storage facilities up to the time of the first independent consultant inspection is presented on pp. 4-6, pp. 11-13 and pp. 17-120 of the 1981 report.

In October 2005, the Units 1-4 L-shaped ash basin dike was overtopped at localized depressed areas of the crest due to a significant storm event. The storm runoff caused overflow of the Suck Creek Diversion Channel, located adjacent to the northwest portion of the Units 1-4 L-shaped dike. The localized dike overtopping and overflow of the Suck Creek Diversion Channel caused localized slope failure and erosion on the downstream slope of the dike. The failed and eroded areas are described in more detail in Chapter 4 of this report.

2.2 SIZE CLASSIFICATION

The ash basin dikes at the Cliffside Steam Station have size classifications as listed in the following table.

		Size Classification	
Structure	Maximum Height (ft)	by Corps of Engineers Criteria	by North Carolina State Criteria
Units 1-4 Dike	38	Small	Medium
Unit 5 Dikes	97	Intermediate	Large
Suck Creek Dikes	120	Large	Very Large

The maximum heights listed above dictate the size classifications.

2.3 HAZARD CLASSIFICATION

All the Cliffside ash basins are classified "low" hazard (Class 3) under the Corps' guidelines and "low" hazard (Class A) by the North Carolina criteria, due to the lack of downstream development.

As previously noted, the Units 1-4 ash basin and the Unit 5 ash basin have been retired and no longer impound any significant volume of water; they no longer serve as impoundments and thus the assigned size and hazard classifications no longer have any relevance with respect to flood hazard.

2.4 GEOLOGY AND SEISMICITY

The Cliffside ash storage basins are located in the Inner Piedmont geologic belt, which is the westernmost of a series of northeast-trending metamorphic belts that comprise the Piedmont Physiographic Province of the southeastern United States (King, 1955). The predominant rocks in the Inner Piedmont are gneiss and schist. However, they are interspersed with granitiods and a few scattered bodies of mafic and ultramafic rocks. The peak of regional metamorphism is considered to have ended in this area in Silurian or Devonian time, some 400 to 375 million years ago (Butler, 1972). The general rock structure in this belt is characterized by irregular foliation of low dip and some broad folds transverse to the northeast regional geologic trend (King, 1955).

The local geology at the Cliffside ash storage basins consists of biotite gneiss and schist with subordinate layers of various metasedimentary rocks (Goldsmith, et al., 1982). Small masses of granitic rock are common in this part of the Inner Piedmont; the Unit 5 ash basin may be just south of such a granitic unit.

The dikes are located in Seismic Zone 2A according to the Uniform Building Code Seismic Zone Map of the United States. According to the publication "Recommended Guidelines for Safety Inspection of Dams", projects that are located in seismic zone 0, 1 and 2 (or 2A) are considered to present "no hazard from earthquakes, provided static stability conditions are satisfactory and conventional safety margins exist".

According to the Corps of Engineers Publication ER1110-2-1806 dated 31 July, 1995, "Earthquake Design for Civil Work Projects", consideration of the presence of liquefaction - susceptible materials in the dam or its foundation is necessary for projects located in seismic zone 2 (or 2A).

3. ENGINEERING AND OPERATIONAL INFORMATION

3.1 ENGINEERING INFORMATION

A description of the design of the Cliffside ash basin dikes is presented in the 1981 independent inspection report.

In 1983, Duke Power engineers made a study of the as-built stability of the slopes of the upstream and downstream dikes of the Suck Creek ash basin based on results of laboratory shear strength testing of undisturbed samples from the in-place embankment soils. A revised design phreatic line for full pond based on piezometer measurements was used in the stability studies. In 1986, Duke re-analyzed stability of the inside slope of the Suck Creek downstream dike under rapid drawdown conditions. In 1997, Duke re-analyzed the downstream slope of the downstream dike of the Suck Creek ash basin to reflect the data available from the installation of two new piezometers in 1995 (P-10 and P-11) and certain adjustments to the geometry used in the 1983 analyses of the downstream slope of this dike.

3.1.1 Slope Stability

The stability analyses, as summarized in the 1986 independent inspection report indicate computed factors of safety which generally meet or exceed the conventional minimum safety factor criteria of 1.5 for steady state seepage conditions and 1.25 for rapid drawdown conditions (where applicable). Some lower-than-minimum safety factors were computed for the inside slope of the Suck Creek downstream dike under steady state conditions. These conditions are for shallow potential failure arcs and are considered to not threaten failure of the dike. A discussion of the original stability analyses is presented in the 1986 independent report. The results of the 1983, 1986 and 1997 analyses of the downstream dike of the Suck Creek ash basin are summarized as follows:

SUCK CREEK ASH BASIN
DOWNSTREAM DIKE

Condition	Slope	Calculated Factor of Safety (FS)		
		1983	1986	1997
Steady State Seepage 1996 Phreatic Line	(Downstream)	----	----	1.69
Steady State Seepage (Future Phreatic Line) (Pond Elevation 772)	(Downstream) (Upper Slope) (Entire Slope)	---- ---- ----	---- ---- ----	---- 1.27(1) 1.38(1)
Steady State Seepage (Original Design Phreatic Line) (Pond El. 772 ft-MSL)	Downstream Upstream	>1.5 1.5(2)	-----	----
Rapid Drawdown (El. 772 to 755 ft-MSL)	Upstream	----	1.76	----

(1) The 1.27 F.S. is for slope above El. 725 Berm. The 1.38 F.S. is for entire slope. An assumed future phreatic surface was used (see table below), with hydrostatic uplift assumed below the phreatic line. This is conservative because less than hydrostatic uplift conditions were measured in P-10 and P-11. The phreatic conditions used are summarized below:

(2) Factors of safety in the range of 1.35 to 1.40 were calculated for shallow (4 to10 ft deep) potential failure arcs on the 2H:1V portion of the inside slope.

PHREATIC ELEVATIONS			
	1983	1997	
Location	Pond at 772	Pond 758	Pond 772
Centerline	766	748	766
OW-7	724	730	735(1)
P-5	664	687	702
OW-8	660	666	676
OW-9	658.5	664	670
Tailwater	655	655	655

(1) Assumed phreatic line rises to elevation 744 about 14 ft horizontally upslope from OW-7.

The 1983 and 1986 analyses were performed by a method of analyses similar to the Ordinary Method of Slices. The 1997 analyses were performed using the modified Bishop method, which is judged to be more accurate for the types of soil strength models used.

The 1983, 1986 and 1997 analyses used soil design parameters as follows:

Material	Unit Wt.	SCU[1] Parameters		SCU_c[2] Parameters	
Foundation Soil	105 pcf	$\phi=25°$,	c=0	$\phi=25°$,	c'=0
Embankment Soil	131 pcf	$\phi=28°$,	c=800 psf	$\phi=34°$,	c'=0
Internal Drain	120 pcf	$\phi=30°$,	c=0	$\phi=30°$,	c'=0

(1) SCU – Saturated Consolidated Undrained Triaxial Test (R)
(2) SCU_c = Saturated Consolidated Undrained Triaxial Test Corrected for Pore Pressure (R)

No stability analyses have been done for the Units 1-4 ash basin dike since the original work in 1956, according to the 1986 report. At that time and at the time of the 1991 report, the Units 1-4 dike was indicated as showing satisfactory performance, and it was judged unnecessary to re-evaluate the soil shear strength parameters and re-analyze this dike. In the 1996 and 2001 inspections, however, features were noted in the crest and downstream slope of this dike that indicated it may be somewhat distressed and that an investigation into its stability was advisable. To our knowledge, such a stability analysis was not performed.

3.1.2 Seismic Conditions

The embankments are all rolled fill construction, wherein the soils were spread in layers and compacted with mechanized equipment. Further, their foundations are not known to contain loose, water deposited sands, the kind of soil that is most susceptible to liquefaction by earthquake loading. The granular drainage blankets are comprised of clean sand or clean cinders having a sand-like gradation, but all these materials would have been compacted since the embankment soils were compacted. It is concluded, based on the available information, that the embankments and their foundations are not subject to liquefaction by earthquake loading.

The Units 1-4 retired ash basin dike is also a rolled fill. Shallow slope failures described in Chapter 4 of the 2001 report indicated that some additional slope movement in this embankment would likely occur as a result of a significant seismic event. The foundation of this retired dike may also contain some recent alluvium. Additional borings were recommended in Chapter 7 of the 2001 report to shed light on the presence and character of any such alluvial soils in the area that was recommended to be investigated. Since the time of the 2001 report, as described in Chapter 4, overtopping, leading to severe eroding and failure of the lower portion of the dike embankment has occurred at several locations. Repair of these areas was ongoing at the time of writing this current report.

3.1.3 Hydrology and Hydraulics

In analyses of the hydrology and hydraulics of the ash storage basins, it was found that the retired Units 1-4 ash basin and the retired Unit 5 ash basin should be capable of safely passing or storing runoff from the 100-year, 24-hour duration storm (7.3 inches rainfall depth). As discussed in Chapter 4, a storm event in October 2005 exceeded this design storm and caused localized overtopping of the retired Units 1-4 ash basin, necessitating current on-going downstream slope repairs. Mr. Steve Hodges of Duke Energy supplied the information that about 10 inches of rain fell over a 24 hour period during the October 2005 storm, corresponding to a 500 year storm event. The previous analyses found that the Suck Creek ash basin should be capable of passing flood runoff from the 1/2 PMP (probable maximum precipitation) storm (18.25 inches rainfall depth in 24 hours), though the margin of freeboard would be small when the basin approaches full capacity with settled ash.

The degree of hydrologic safety demonstrated by the existing analyses for the Units 1-4 ash basin and the Unit 5 ash basin (i.e., both safe for the 100-year storm) is adequate, in our opinion, for these retired basins which no longer serve as impoundments. For the Units 1-4 ash basin, this is contingent upon repairs being made to the downstream slope to restore the original design cross-section that was eroded in localized areas during the October 2005 storm event. The capability of the Suck Creek ash basin to pass a flood produced by 1/2 PMP is adequate according to the safe design flood criteria by both the Corps of Engineers and the State of North Carolina.

No changes or modifications have been made at the basins which would significantly change the assumptions of the existing hydrologic/hydraulic analyses; thus, no further study of hydrology or hydraulics appears warranted at this time. Pertinent hydraulic data and results of the analyses were presented in the 1986 independent inspection report.

3.2 OPERATIONS RELATED TO PROJECT SAFETY

Operation of the Cliffside ash basins is described in the 1981 independent inspection report. We have not been informed of any major additions or modifications to the ash storage facilities planned by Duke at this time.

Safety related operations at the subject facilities involve routine inspection and maintenance as required. Inspections are carried out by Duke personnel and by outside consultants.

Plant personnel perform routine inspections of the subject facilities. Duke design engineers make annual inspections and prepare written reports documenting their observations. At five-year intervals, independent inspections by outside consultants are performed per NCUC-regulations; these inspections are also documented by written reports.

4. FIELD INSPECTION OBSERVATIONS

The field inspection was done on September 6, 2006, by Mr. Mel Y. Browning, P.E. of MACTEC in company with Mr. Kelly Allison of Duke. Mr. Steve Hodges, who is responsible for on-site dike routine inspections and monitoring and Mr. Lynn Mathis of Facilities Planning and Siting, Inc. (FPS) were present for the initial portion of the inspection of the retired Units 1-4 ash basin. Weather conditions during the inspection were partly cloudy. Water level in the Suck Creek ash basin at the time of inspection was measured to be at 764.5, which is about 7.45 ft below the maximum stop-log elevation. The only water contained in the old Units 1-4 ash basin is yard drainage and water from dredging operations; the water level was observed to be well below the elevation (692 ft-MSL) of the stop logs at the old drainage tower. The retired Unit 5 ash basin contains no visible water. The old drainage tower had been removed. Conditions observed are presented below. Photographs referenced below are contained in Appendix B. Any references to left and right are relative to an observer facing downstream.

4.1 UNITS 1-4 RETIRED ASH BASIN DIKE AND OUTLET WORKS

In October, 2005, a severe, previously discussed rainfall event occurred at the site. This event caused overflow in the Suck Creek Diversion canal located along the northwest side of the Units 1-4 ash basin dike, leading to overtopping of the dike at depressed locations of the crest and severe erosion of the lower portion of the downstream slope at several locations. Duke engaged Facilities Planning and Siting, Inc. of Charlotte (FPS) to produce repair drawings and to subcontract a grading contractor to oversee and perform the repairs. The damage locations are shown on Figures 3 and 3A. MACTEC was hired by FPS to provide engineering assistance regarding repair methodology and to provide soil technician services to observe the repair work and perform soil compaction testing during placement of structural fill. Repair plans call for restoring the failed and eroded areas to the previous slope contours and raising the crest of the Units 1-4 dike by about 1 ft.

Water levels in the yard drainage holding pond and dredge spoil area were relatively low at the time of inspection. In Photograph 4-5A, vegetation obscured the view of the water.

The downstream slope of the Units 1-4 retired ash basin dike is overgrown with trees and other vegetation as described in the earlier independent inspections. The crest, shown in Photographs 4-1, 4-2 and 4-3 has trees overhanging it. There are depressions that pond water at some locations in the surface of the crest, although no ponded water was present due to preceding dry weather. Depressions or "undulations" were first observed in the crest between approximately station 10+00 and 12+50 in the 1996 inspection. A chain link fence along the western (inside) edge of the crest that was added between the 1986 and 1991 independent inspections shows sags in the same area as the crest undulations (Photograph 4-2). This implies that the undulations formed since the fence was installed. These depressions or undulations were still evident in the current 2006 inspection, and appear essentially the same as they did in 1996 and 2001.

The inside (upstream) slope of the dike is almost completely buried with ash; only the upper part of the slope above ash level is visible. No signs of slumping or shear failure were observed on this slope. The outside (downstream) slope of the north end is grassed (Photograph 4-4). In 2001, the vegetation showed minor, insignificant disturbance by mowing equipment in a few local places. In 2006, the slope surface was obscured by high grass cover.

A view of the wooded outside (downstream) slope of the Units 1-4 ash basin dike is shown in Photograph 4-6. Trees on the downstream slope that had been overturned at the time of the 1991, 1996 and 2001 reports are still visible. As noted in earlier inspections, the inspection trail located along the toe of this slope is still overgrown (Photograph 4-6) and more so than 2001. In 2001, signs of shallow slope failures were observed on the slope between approximately stations 11+00 and 13+00. In 2006, such shallow slump failures and erosion were noted at several locations on the downstream slope, (Photographs 4-6A and 4-8B). However, much more significant distress was observed in the 2006 inspection, caused by the October 2005 storm event. Overflow of the retired Unit 1-4 Ash Basin, along with overflow of the Suck Creek Diversion Channel, caused localized failure and erosion on the downstream slopes of the dike at the numerous locations depicted on Figures 3 and 3A. Significant distress occurred within the original flat area between the toe of the dike and the bank of the Broad River, between about Station 6+50 to 8+50. Within this area, up to about 15 ft of the original soil overburden failed and was removed by the flood event, with a vertical soil face along the dike side of the failure area. Other similar but more localized soil failure areas are present at about Station 3+00 and 14+00. In these two latter areas, the failed and eroded soil volume extends laterally from the Broad River up to about the mid-height of the downstream slope of the dike. Seepage was not observed on the sidewalls of the failed and eroded areas. These failed and eroded areas are seen in Photographs 4-4A, 4-4B, 4-6C, 4-7B, 4-7C, 4-8A and 4-8C.

As is the case for the downstream slope of the dike, conditions along the bank of the river are worse than in 2001. As seen in the previously discussed photographs, the failed and eroded areas extended down to the river bank in several areas. Old CMP drainage pipes (corrugated metal pipes) were observed (Photograph 4-8) which have been undermined since 2001.

The visible part of the drainage tower is shown in Photograph 4-9, and the outlet end of the 30-inch diameter CMP outlet is shown in Photograph 4-10 and 4-10A. The drainage structure still appeared to be in fair condition. The steel frame on top of the drainage tower is rusty. High grass obscured the lower portion of the drainage tower legs. A small trickle of red colored water was observed to flow from the end of the outlet pipe. As part of the 1996 inspection, the sediment was sampled and sent to Duke's Metallurgy Laboratory where energy-dispersive spectroscopy was performed and the sample was determined to be primarily iron oxide (letter dated January 2, 1997 to Mr. Mike Martin from Ms. Sue Anderson of the Metallurgy Laboratory). As seen in photograph 4-10A, erosion and undermining of the outlet pipe concrete flume has occurred since 2001, apparently due to the October 2005 storm event.

4.2 UNIT 5 RETIRED ASH BASIN DIKES AND OUTLET WORKS

The crest of the Unit 5 retired ash basin dike was observed to be in good condition with no tension cracks or major depressions. The ash in the filled basin is developing a vegetative cover including trees.

An overall view of the outside (downstream) slope of the Unit 5 ash basin main dike is shown in Photograph 4-11. In 2001, this slope was observed to be covered with a good growth of grass. No slumps, slides or significant erosion were seen on this slope in 2001. In 2006, high grass obscured the slope. No seepage or wet areas were observed on the slope above the toe. The areas of clear seepage and the swampy area noted at the downstream toe of the main dike in all the previous inspections were observed to be essentially unchanged. The swampy area located next to the rip-rapped toe below the right (east) abutment is shown in Photograph 4-12 and, as in 2001, is currently flooded to shallow depth by a beaver pond located downstream of the area. Bushes and small trees continue to grow in the riprap. and should be removed (Photograph 4-12A).

Clear seepage that was emerging at the downstream toe of the saddle dike above Cooling Tower B (in the vegetated area visible above the tree and the otherwise grassed slope in Photograph 4-12B) was not observed in 2001 or the current 2006 inspection. In 2001, Mr. Hodges had noted that water ponds in the drainage ditch located well beyond and below the toe of the saddle dike near the cooling tower. The source of the water in this ditch was believed to be spring seepage from natural ground below the downstream right abutment of the saddle dike. The downstream slope of the saddle dike (see Photograph 4-12B) was observed to be grassed and free of obvious seepage or wet areas. However, high grass growth obscured the slope and prevented a more thorough inspection. No slumps, slides or other evidence of shear failure were observed on this slope. Granular drainage has been constructed to intercept emerging seepage on the left abutment of this saddle dike (see the rock-filled trench visible on the left in Photograph 4-12B).

In 2006, the Unit 5 retired ash basin drainage tower was either hidden by vegetation or had been removed. The tower may be seen in Photograph 4-13 of the 1991 inspection report. The inlet level for stormwater in the filled basin to escape through this tower is estimated to be at elevation 759.5 ft or 7.5 ft below the crest of the dike, based on measurements made on the tower during the 1996 inspection visit. The outlet end of the 60-inch diameter RCP (reinforced concrete pipe) outlet is shown in Photograph 4-14. The pipe appeared to be in the same relatively good condition at its outlet end as in the 1991, 1996 and 2001 inspections. Little or no water was flowing in the pipe at the time of the current inspection. The stilling basin into which the pipe empties appears in good condition. Apparent moisture collection forms the visual "grid" pattern on the inside walls of this reinforced concrete basin; no free seepage was observed on the insides of the walls.

4.3 SUCK CREEK ASH BASIN DIKES AND OUTLET WORKS

4.3.1 Downstream Dike

The crest of the downstream dike of the Suck Creek ash basin was observed to be in good condition with no visible tension cracks, major depressions, sags or other signs of shear failure or excessive settlement; a view of the crest is shown in Photograph 4-15.

The inside (upstream) slope of the downstream dike was observed to be in good condition but high grass as shown in Photograph 4-16 obscured the slope. There were no obvious signs of shear failure or major erosion on this slope. The rip-rap lined intercept ditches at the abutment contacts were in good visual condition. Minor damage to the right hand ditch by mowing equipment tires is visible in Photograph 4-17, and appears unchanged since the 1996 and 2001 inspections.

The outside (downstream) slope of the downstream dike was observed to be in generally good condition, but somewhat obscured by high grass. Views of this slope are shown in Photographs 4-17 and 4-18. A former slump in the left abutment just below the upper berm had been repaired previously; the rip-rap covering the repaired slump area is shown in Photograph 4-19. The minor erosion at the toe of this rip-rap covering appears similar to the 1996 and 2001 photograph; this area can be repaired using gravel (No. 67 or 76) to stabilize the erosion.

At the time of the 1995 annual Duke inspection (December 2, 1995), their report states: "some wetness was observed along the downstream right abutment, just above the elevation 725 berm, however no water was flowing in the toe ditch". However, no seepage or wet areas were observed on the downstream slope during the 1996, 2001 and current 2006 independent inspections, and no signs of major slope failure or significant erosion were seen on this slope.

As shown in Photograph 4-19A, large pieces of weathered rock were observed to have fallen from the rock ledge located at the left abutment contact with the lower part of the outer slope. Some of this rock has fallen into and partially blocks the riprap-lined ditch located at the left abutment contact. The situation appears essentially the same as it did in the 1996 and 2001 inspections.

This does not appear to be causing any problems at present, but should be monitored during the routine inspections. However, vegetation is present in the rip-rap up against the rock ledge, which will inhibit determining if additional rock falls from the ledge onto the rip-rap. This vegetation should be removed.

The rip-rap-lined channel leading from the toe of the downstream dike to the river is shown in Photograph 4-20, and the toe of the dike is shown in Photographs 4-21 and 4-21A. Beaver damming across the outlets of this channel at the river bank present at the 1996 inspection had been removed prior to the 2001 inspection. The flow of water from the toe of the dike into the channel, which had been observed in the pre-1996 inspections, was visible in 2001 and in the current 2006 inspection. The observed seepage was clear. However, vegetative growth in the channel bottom made inspection of the seepage difficult and should be removed. (At the time of the 1986 inspection, no water had been observed flowing from the toe of the dike though the channel bottom next to the toe but the toe was damp and overgrown with cattails and other vegetation.)

4.3.2 Upstream Dike

Views of the crest inside (upstream) slope and outside (downstream) slope of the upstream dike of the Suck Creek ash basin are shown in Photographs 4-23, 4-24 and 4-25, respectively. High grass obscured the slopes. Overall, this dike was observed to be in good condition. The grassing on the slopes was observed to be good with no significant erosion noted. No tension cracks or major depressions were seen on the crest and no major depressions were seen on the crest. No slumps, slides or other signs of shear failure were seen on the slopes. No animal burrows were observed during this present inspection. The rip-rap-lined abutment contact ditches were observed to be in good condition and unobstructed. Clear seepage was observed in the lower part of the right side abutment ditch near the top of the rip-rap toe. The rip-rap at the toe of the downstream slope of the dike was observed to contain weedy growth, briars and vines (Photograph 4-26). In 2001, the vegetation in the flat toe area had been cleared to about 15 ft beyond the toe as recommended in the 1996 inspection. In 2006, vegetation had become reestablished in this area, which should be removed. The relatively flat area beyond the toe was swampy and soft, as shown in Photograph 4-26, with areas of clear standing water and seepage. The vegetation prevented thorough viewing of the flat area beyond the top, but to the extent viewable, there was no evidence of boils or fast flowing seeps carrying soil particles.

4.3.3 Outlet Works

The visible part of the drainage tower is shown in Photograph 4-27 and the outlet end of the 42-inch diameter reinforced concrete bottom discharge pipe is shown in Photograph 4-28. These structures were observed to be in good condition. Discharge from the pipe was clear, and no dropouts or sinkholes were observed in the soils over the buried outlet pipe. No seepage was observed around the outside of the pipe at the outlet end.

5. PREVIOUS INSPECTION AND PERTINENT REPORTS

Up through 2001, Duke engineers had made annual inspections. An independent consultant inspection is performed every five years. Since the 2001 report, annual inspections of the dikes have not been consistently performed by Duke. The last two independent inspection reports (1996 and 2001) were reviewed. Neither of these reports indicated any serious conditions which would immediately jeopardize the safety of the Cliffside ash basin dikes. The significant storm event previously noted herein occurred in October 2005. The distress caused by this storm event to the retired Units 1-4 ash basin is serious and repair of these distressed areas is discussed in this report.

6. MONITORING INFORMATION

In August 1983, three piezometers (P4 through P6) were installed 38.4 to 41.4 ft deep in the downstream dike of the Suck Creek ash basin; three (P1 through P3) were installed along the outside edge of the crest. Each of these piezometers was sealed about 7 ft above the bottom of the pipe. Other details of installation for these piezometers were included in the 1986 independent inspection report. In February 1987, three observation wells (OW-7, OW-8 and OW-9) were installed in the downstream dike of the Suck Creek ash basin. Logs of installation for the three observation wells were presented in Appendix C of the 1991 inspection report. Water level readings in the piezometers typically have been taken on a monthly basis since installation.

In October 1995, two piezometers (CLMW-05S and 05D, P-11 and P-10, respectively) with respective sealed intervals from 48 to 60 ft and 92 to 104 ft were installed on the crest, with installation details presented in Appendix C of the 1996 inspection report.

In November 2001, two observation wells (OW-10 and OW-11) were installed on the downstream slope of the downstream dike of the Suck Creek ash basin. OW-10 was installed on the slope about 25 to 30 ft horizontally upslope from OW-7. OW-11 was installed on the slope about 60 ft horizontally downslope from P-3. These were installed to respond to a recommendation for their installation contained in the 1996 inspection report. The logs for these installations are contained in Appendix C of the 2001 Inspection Report.

Approximate locations of all the above are shown on Figure C-1 in Appendix C. The individual readings of the piezometers and of the water levels in the Suck Creek ash basin are plotted in Appendix C. The pond level between the years 1989 and 1999 fluctuated between elevation 755 and about 758 ft-MSL. Beginning in early 2000, the pond was raised and fluctuated between 762 and about 762.5 (full pond is to be 772 ft) up to late 2004. The pond level dropped briefly to about 758.5 ft during the first quarter of 2005, then was raised to about elevation 764 through the remainder of 2005. The brief high pond level of the Suck Creek ash basin associated with the October 2005 storm event is not captured in the pond level data. (Pond level readings bracketing the October 2005 storm event were taken on September 28, 2005, October 27, 2005 and November 30, 2005. These three readings only varied from 763.5 to 763.7 ft). Beginning in early 2006, the pond was raised briefly to 765 ft and then ranged between 764.3 and 764.7 through the last reading on May 31, 2006 provided by Duke. The water levels in piezometers P-4, P-5 and P-6 and observation wells OW-8 and OW-9, all located above the horizontal drainage blanket of the dike, have varied little. However, the level in OW-7 fluctuates considerably, and rose about 22 ft from the fall of 1992 to the late spring of 1993, and then fluctuated about 10 ft annually; since mid-1998, OW-7 has fluctuated about 5 to 6 ft annually. There appears to be a seasonal cycle in fluctuations at OW-7 with the highest water elevations occurring in the late winter and spring and the lowest in the fall. This is similar to the seasonal cycle of natural ground water elevations, suggesting that OW-7 may be affected by rainfall and/or evapotranspiration. OW-10 was installed to verify the depth of the phreatic line under the downstream slope near OW-7. From the time of its installation in late 2001 through mid 2006, the readings in OW-10 have mirrored the approximate 5 ft fluctuations of OW-7, higher in the spring and lower in the summer and early fall. The readings of OW-10 are typically about 1 to 3 ft higher than those of OW-7, which is understandable and expected given OW-10's higher position on the slope. Thus, the readings of OW-10 confirm the reliability of the phreatic surface readings of OW-7.

Piezometer P-2, upslope from OW-7, has a measuring interval between about elevations 723 and 730 and had a relatively constant water elevation between about 726 and 730 until 1995, when it rose to about elevation 740 by the end of 1995, which was some 8 ft above the top of its measuring interval. Thereafter, with some fluctuation, P-2 remained usually between elevations 730 and 742 until the end of 1998, when is it declined to about 730 and then fluctuated between about 726 and 731 until late 2002. From late 2002 to mid 2006, P-2 typically ranged from about 740 to 745 with two late in the year drops to about 730 in late 2003 and late 2004. Piezometer P11, intended to supplement P-2, was within the fluctuation range of P-2, until P-2 declined in late 1998 and early 1999 and P-11 remain relatively constant and showed a slight increase in elevation corresponding to the increase in pond elevation in the early part of 2000. (P-2 did not increase in response to the raising of the pond). From late 2002 to mid 2006, P-11 has ranged from 740 to 745, almost exactly mirroring the readings of P-2, except for the two apparent anomalous P-2 readings of 730 in late 2003 and late 2004. P-10, located the same distance from the pond contact with the upstream slope as is P-11 but closer to the left abutment, read 20 to 25 ft deeper than did P-11 through late 2002 and has read 30 to 35 ft deeper since this time. However, P-10 has a deeper sealed interval than does P-11. Piezometer P-1 and P-3 have approximately the same measuring interval as P-2. Piezometer P-1 also showed a significant rise of 9 or 10 ft in piezometric head to about elevation

735 after the end of 1994 until early 2000, when it declined to about elevation 730 through the end of 2002 in spite of the raising of the pond elevation at about this same time. From early 2003 to mid 2006, P-1 has remained relatively constant at about 738 to 740 ft. Piezometer P-3 showed about 20 ft of rise in piezometric head, to about elevation 746 in early 1998. Like P-1, P-3 then also declined in the period beginning just before and continuing after the pond elevation increase which took place in early 2000. During the 2001 inspection, Mr. Steve Hodges informed that piezometer P3 is sometimes difficult to read, often producing an indication of water at about 34 ft and then again at about 51-52 feet. Since early 2003, P-3 has read mostly between 745 and 750 until mid 2006, with a few apparently anomalous readings of 730 ft during this period, possibly due to the difficulty in reading this piezometer since the pond level remained relatively constant at 762 to 764 ft during this period. Since the time of its installation in November 2001, OW-11 has typically read between 735 and 738 ft. Since the end of 2003, the OW-11 readings have been about 10 to 15 ft lower than the predominant P-3 readings of 740 to 745 ft.

The years 2000 and 2001 experienced unusually dry weather conditions; this suggests the decline in water elevations in P-1, P-2 and P-3 in spite of an increase in pond elevation in early 2000, was related to weather conditions. Since early 2003, P-1, P-2 and P-3 have increased with the pond level. Also, Piezometer P-11 and to a lesser extent P-10 appear to be influenced by the pond elevation.

Table C-1 summarizes the stability analysis phreatic line elevations at the locations of the piezometers and observation wells, and summarizes the highest readings to date in each location for comparison with the elevations used for stability analysis.

No settlement monuments or other instrumentation besides the piezometers and observation wells described above are monitored at the Cliffside ash basin dikes.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

As previously discussed in this report, severe erosion and slope failures were noted in several areas of the downstream slope of the Units 1-4 retired ash basin dike. Repair of these areas was underway by Facilities Planning and Siting at the time of writing of this report. Monitoring and fill compaction testing were being performed by MACTEC, subcontracted to FPS.

The downstream slope repairs were targeted toward the major distress and erosion caused by the October 2005, storm event. Apparent old shallow slump and erosion noted on the upper portions of the downstream slope in 1996, 2001, and 2006 were typically not repaired. The repair included placing about 1 ft of new fill over the previous dike crest, leveling the crest and obscuring the previously noted undulations in the dam crest.

This 2006 inspection found no obvious signs of imminent instability or serious inadequacy of the other dikes and outlet structures at the Cliffside Steam Station that would require emergency remedial action.

The conditions observed at the other ash basin dikes are essentially the same as those observed in the earlier independent inspections, except that mowing of grass had not being performed at the time of the 2006 inspection.

Both the upstream and downstream dikes at the Suck Creek ash basin are in generally good visual condition. The grass on these dikes is generally well established but needs to be mowed to allow for inspection of the slopes. The small slump noted in the 1986 independent inspection on the outside slope near the left abutment of the downstream dike has apparently been repaired because no signs of the slump were observed in the 1991, 1996, 2001 and 2006 inspections. The clear seepage emerging into the drainage channel at the toe of the downstream dike probably comes from the drainage blanket. The wet area observed just beyond the rip-rapped toe of the outside slope of the upstream dike appeared to be similar as observed during the previous independent inspections but growth of vegetation in this area made visual inspection difficult.

The water levels in the piezometers and observation wells in the downstream dike of the Suck Creek ash basin are below the design phreatic line, however, the pond has never been higher than about 7 ft below the 772 ft design full pond and yet the water depth readings in OW-7 have approached the depth assumed for the design phreatic line under full pond. Piezometer P-2, upslope of OW-7, has indicated a maximum piezometric reading that is about 19 ft below the design phreatic line. However, P-2 is a piezometer with the top of its sealed (measuring) interval at about elevations 730, which is 15 ft below the measured maximum phreatic level and 34 ft below the design phreatic line. Thus, P-2 functions as an observation well to measure the phreatic surface only when the piezometric reading is lower than the top of the sealed interval (723). Otherwise, the piezometric level in its measuring interval is actually lower than the phreatic line since there is a vertical seepage gradient as indicated by P-11 and P-10.

Since its installation in November 2001, the phreatic surface readings of OW-10 have essentially mirrored the readings of OW-7, but about 2 ft higher than the readings of OW-7. This is understandable and expected since OW-10 is at slightly higher elevation on the slope than OW-7. The readings of OW-10 have ranged from about 720 to 731 ft. The readings of OW-10 confirm the validity of the readings of OW-7. The readings of OW-11, located even higher on the slope than OW-10, have varied from about 733 to 739, again tending to validate the previous results of OW-7.

The hydrologic analyses indicate that the Units 1-4 retired ash basin and the Unit 5 retired ash basin have the capability of containing or passing runoff from the 100-year storm without overtopping. This degree of hydrologic safety is adequate, in our opinion, for the retired basins which no longer serve as impoundments. The October 2005 storm event that caused overtopping of the Units 1-4 old dike was estimated to be a 500 year storm. However, considering that the basin is retired, in our opinion, the 100 year criterion is still adequate. The degree of hydrologic safety of the Suck Creek ash basin meets the criteria established by the Corps of Engineers and the North Carolina Dam Safety regulations. No changes from the 1986 and 1991 independent inspections were observed that would have a potentially serious impact on the assumptions used in the hydrologic analyses. No further study of the safety of the dikes with respect to flood hazard appears warranted at this time.

The 1983 static slope stability analyses of the ash basin dikes at Cliffside indicated computed factors of safety for deep seated potential failure arcs that meet or exceed conventional minimum safety factor criteria, though some lower-than-minimum factors of safety are indicated for shallow (less than 10 ft) potential failure arcs on the inside slope of the Suck Creek downstream dike. There is also an indication, as described earlier, that the design phreatic line used in the slope stability analyses of the Suck Creek downstream dike may be exceeded under future conditions. This will affect the stability. The less than hydrostatic uplift conditions on deeper potential failure surfaces means that the safety factors computed on deep failure surfaces will be too low (too conservative) since hydrostatic uplift assumptions are used. With this in mind, the 1997 analyses reported in Section 3.1.1 showed that, under the then existing conditions (pond elevation 758 or lower) the safety factor of the downstream slope is well above 1.5 (1.69). Because of the higher than "theoretical" phreatic line being indicated by the measurements, prediction of the final phreatic line under full pond (elevation 772) conditions would require special computations (finite element or finite difference modelling) that are not normally done for ash dikes. Therefore, a reasonable assumption of the possible future phreatic surface was made and 1997 calculations by Duke produced the conservative safety factors in Section 3.1.1, which are below the desired value, particularly for the upper part of the slope. Since it is not known how accurately the future phreatic surface was assumed for these calculations, and since the calculations show the slope has adequate safety factor under 1996 conditions, future inspections will have to evaluate phreatic line behavior at higher pond elevations in order to decide what, if any, remedial features are needed before full pond at elevation 772 can be safely achieved. Table C-1 in Appendix C should be updated annually with the highest readings achieved to date for comparison with the analysis phreatic elevation.

Methods of maintenance and surveillance, as they relate to overall project safety, appear to be reasonably adequate but with concerns listed below. Maintenance should continue as needed to keep a good stand of erosion resistant grass on the slopes of the ash dikes particularly the Suck Creek dikes and to keep the rip-rap-lined channel and ditches free of vegetation and other obstructions such as the rocks that have fallen from the weathered rock ledge into the left abutment contact ditch next to the outside slope of the Suck Creek downstream dike. Mowing of grass was overdue at the time of 2006 inspection.

Since the 2001 inspection, the program of annual inspections performed by Duke engineers has not been maintained. Also, responsibility for maintaining instrument readings and plotting of data has been assigned to personnel at the individual stations. Previously, this was the responsibility of an individual at Duke Corporate with knowledge of previous inspection reports and familiarity with the previous instrument readings. The actual readings themselves, as before, are being taken by local station personnel, in this case Mr. Steve Hodges, who is also responsible for the on-going maintenance of the dikes and outlet works. The plots of the readings had not been maintained and assessed for their engineering significance as it was unclear who had this responsibility. We recommend that Duke reinstitute more centralized responsibility for the receiving and plotting of data from the dikes at the individual stations, in order to ensure that the data are plotted on a regular basis to facilitate engineering evaluation of any changes requiring attention prior to the 5 year inspections. The annual inspections by Duke engineers should also be reinstated and the plotted instrument readings up to the time of each annual inspection used to help evaluate any changes noted in the annual inspections.

7.2 RECOMMENDATIONS

General

1. No further study of hydrologic safety is recommended at this time.

2. The grassed slopes of the dikes should continue to be reseeded in areas where equipment has disturbed the vegetation, and the existing maintenance program should be continued and upgraded to include regular mowing of the slopes.

3. Burrowing animals should be prevented from establishing themselves on the dike slopes and abutments. A maintenance program in which the grass cover is mowed at least twice yearly is very helpful in this regard because it denies protective cover to these animals.

Suck Creek

4. Quantitative monitoring of the Suck Creek basin water level and the piezometer water levels should continue on a monthly basis. This is important to reliably measure the rise in phreatic elevations versus future rise in pond elevations to assess the full pond stability calculations described in Section 3.1.1 and in the next to last paragraph of Section 7.1. Table C-1 in Appendix C should be updated annually for the highest reading to date and this should be compared to the analysis phreatic elevations.

5. The swamp area at the downstream toe of the Suck Creek upstream dike should have existing vegetation removed and vegetation controlled for a distance of at least 15 ft from the toe to facilitate inspection observations of this swampy seepage area. At least annually, the vegetation in this area should be cut by hand. Construction of surface ditches to drain this area would be helpful in accessing the area for vegetation control.

6. The vegetation in the rock rip-rap toe area of the Suck Creek upstream dike should be removed and then controlled by annual application of herbicide.

Unit 5 Retired Basin

7. It is recommended that the retired Unit 5 basin dike be inspected during annual inspections performed by Duke engineers; they also should be inspected by plant personnel after unusually heavy rainfalls.

8. The vegetation in the rock rip-rap toe area of the Unit 5 basin (retired) dike should be controlled by annual application of herbicide. The small trees and larger shrubs should be cut by hand and removed.

Units 1-4 Retired Basin

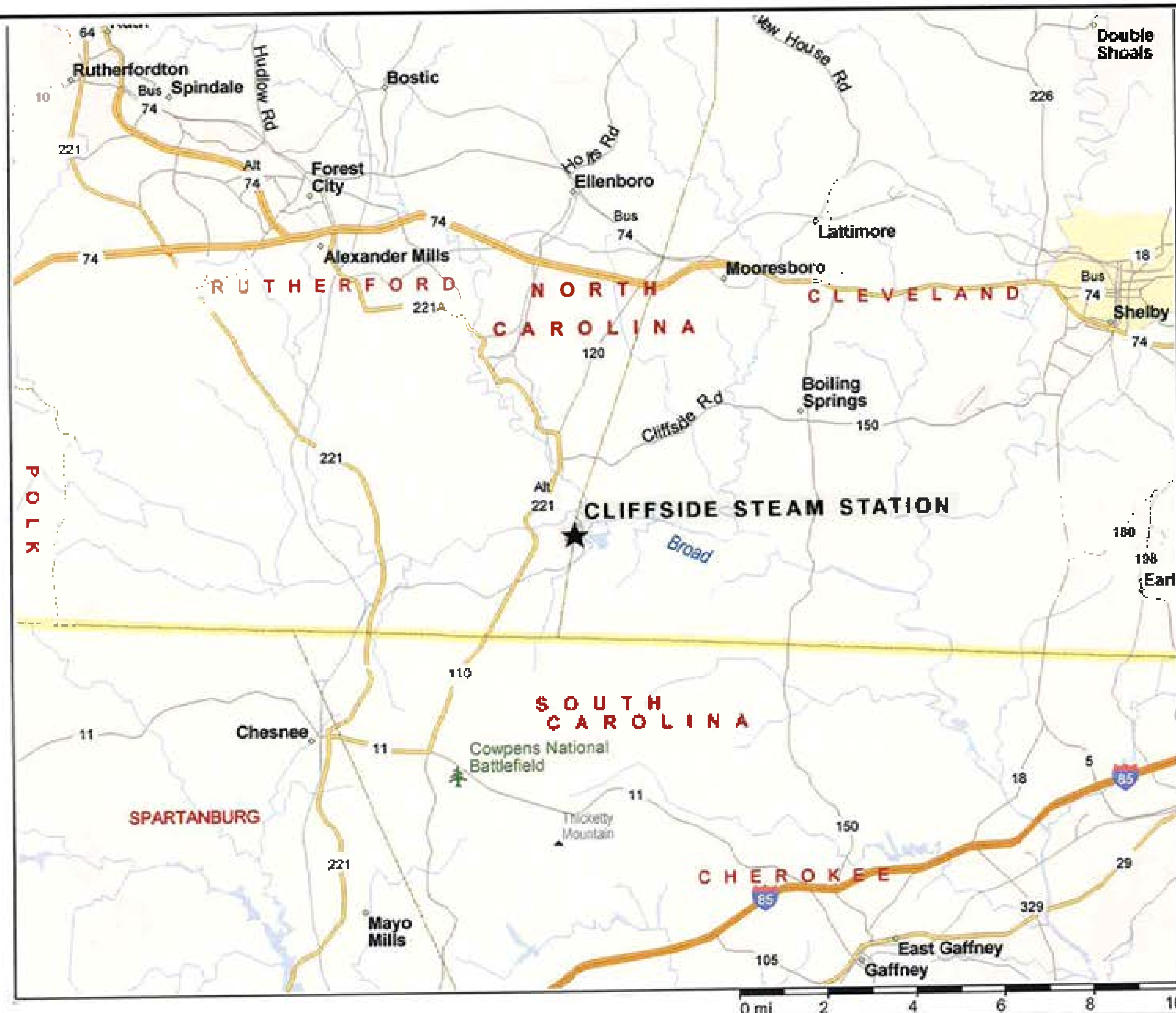
9. It is recommended that the retired Units 1-4 basin dike be inspected during the annual inspections performed by Duke engineers; it also should be inspected by plant personnel after unusually heavy rainfalls, or during high river stages. It is recommended that inspection trails be cleared at least once a year, just prior to the annual inspections, along the toes of the outside slopes of the retired Unit 1-4 dike to facilitate the inspections.

10. Repair of the Units 1-4 retired ash basin will include not only the downstream slopes, but also placement of about 1 ft of new fill on the crest of the dike to create a level surface. This will remove the previous undulating area of the crest noted in this report. We recommend that the new dike crest be monitored for any reoccurrence of irregular surface settlement. If such settlement is detected, further investigation (see below) and/or remedial action will be necessary.

11. If careful site observation during future annual inspection detects undulation of the crest, as previously noted prior to the new repairs, at least two soil test borings sampled at 2.5 ft intervals to a depth of at least 15 ft below the base of the embankment soil should be made in the crest of the Units 1-4 retired ash dike in the undulating area to explore soil conditions. The boring operations should be field-observed by an engineer experienced in geotechnical and embankment engineering. The engineer should direct the driller to obtain undisturbed samples for laboratory testing if this is judged to be advisable based on the conditions being encountered.

APPENDIX A

FIGURES



REFERENCE DRAWING: 1988-2003 MICROSOFT CORP. AND/OR ITS SUPPLIERS.

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CHARLOTTE, NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE
MRK	1-8-07	MYB	1-8-07

SITE VICINITY MAP

CLIFFSIDE UNITS 1-4 OLD ASH STORAGE BASIN
RUTHERFORD AND CLEVELAND COUNTIES
RUTHERFORD AND CLEVELAND CO., NORTH CAROLINA

JOB NO.	FIGURE
6234-06-3843	1

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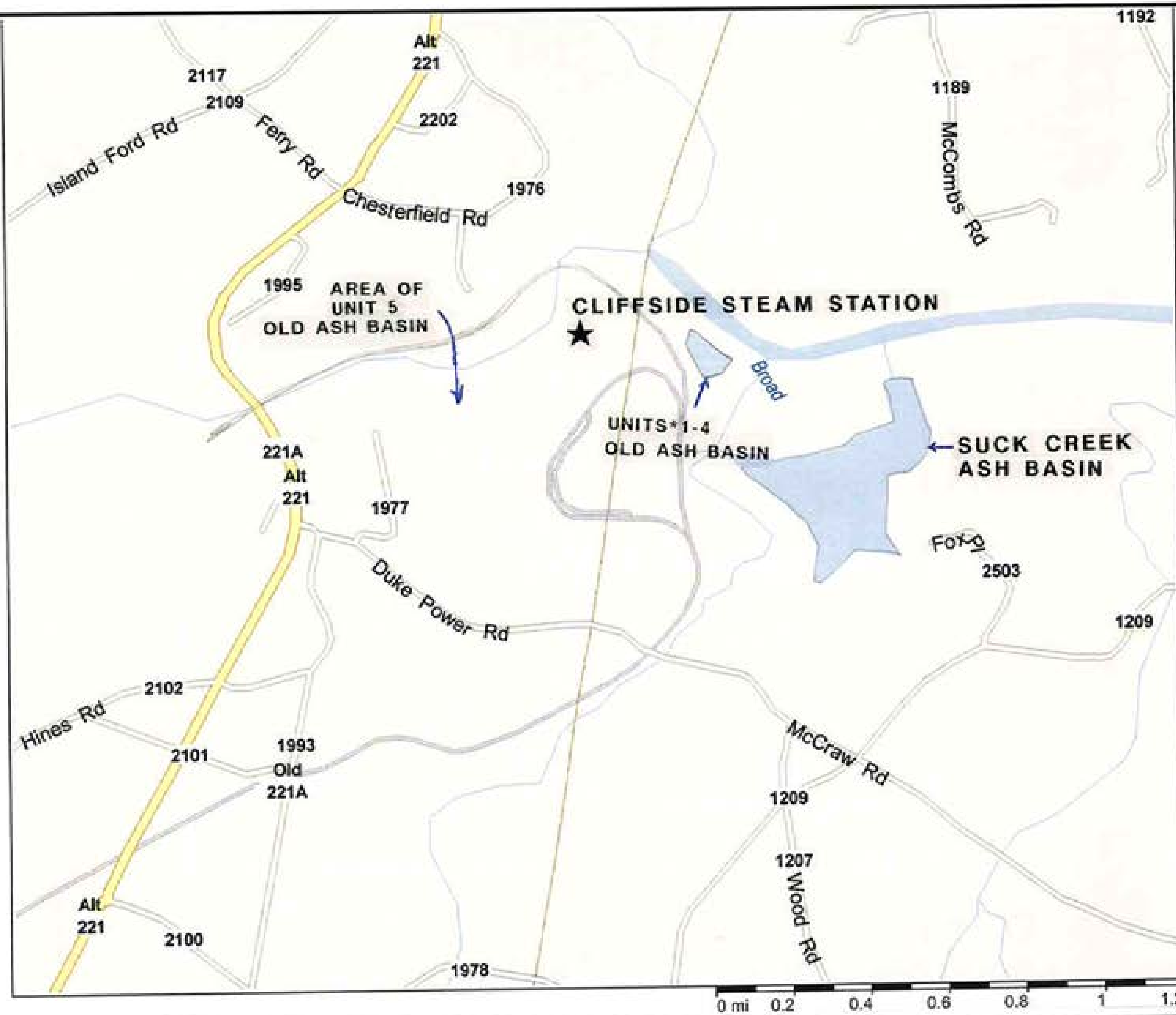

REFERENCE DRAWING: 1988-2003 MICROSOFT CORP. AND/OR ITS SUPPLIERS.

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STIE LOCATION

CLIFFSIDE UNITS 1-4 OLD ASH STORAGE BASIN
RUTHERFORD AND CLEVELAND COUNTIES
RUTHERFORD AND CLEVELAND CO., NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE	JOB NO.	FIGURE
[illegible]	1-8-07	MTB	1-8-07	6234-06-3843	2

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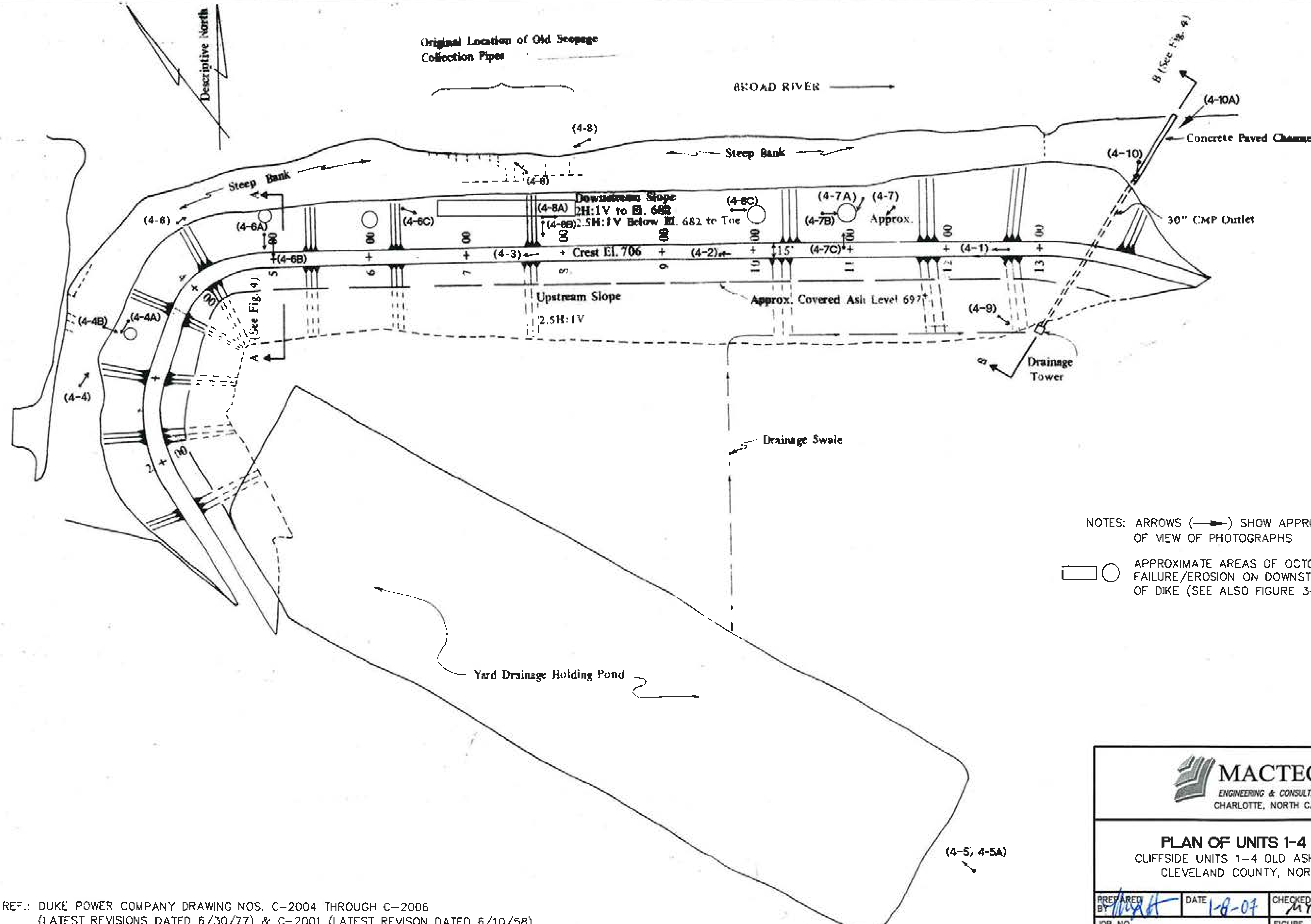

NOTES: ARROWS (——▶) SHOW APPROXIMATE DIRECTION OF VIEW OF PHOTOGRAPHS

APPROXIMATE AREAS OF OCTOBER, 2005 FAILURE/EROSION ON DOWNSTREAM SLOPE OF DIKE (SEE ALSO FIGURE 3-A)

REF.: DUKE POWER COMPANY DRAWING NOS. C-2004 THROUGH C-2006
(LATEST REVISIONS DATED 6/30/77) & C-2001 (LATEST REVISON DATED 6/10/58)

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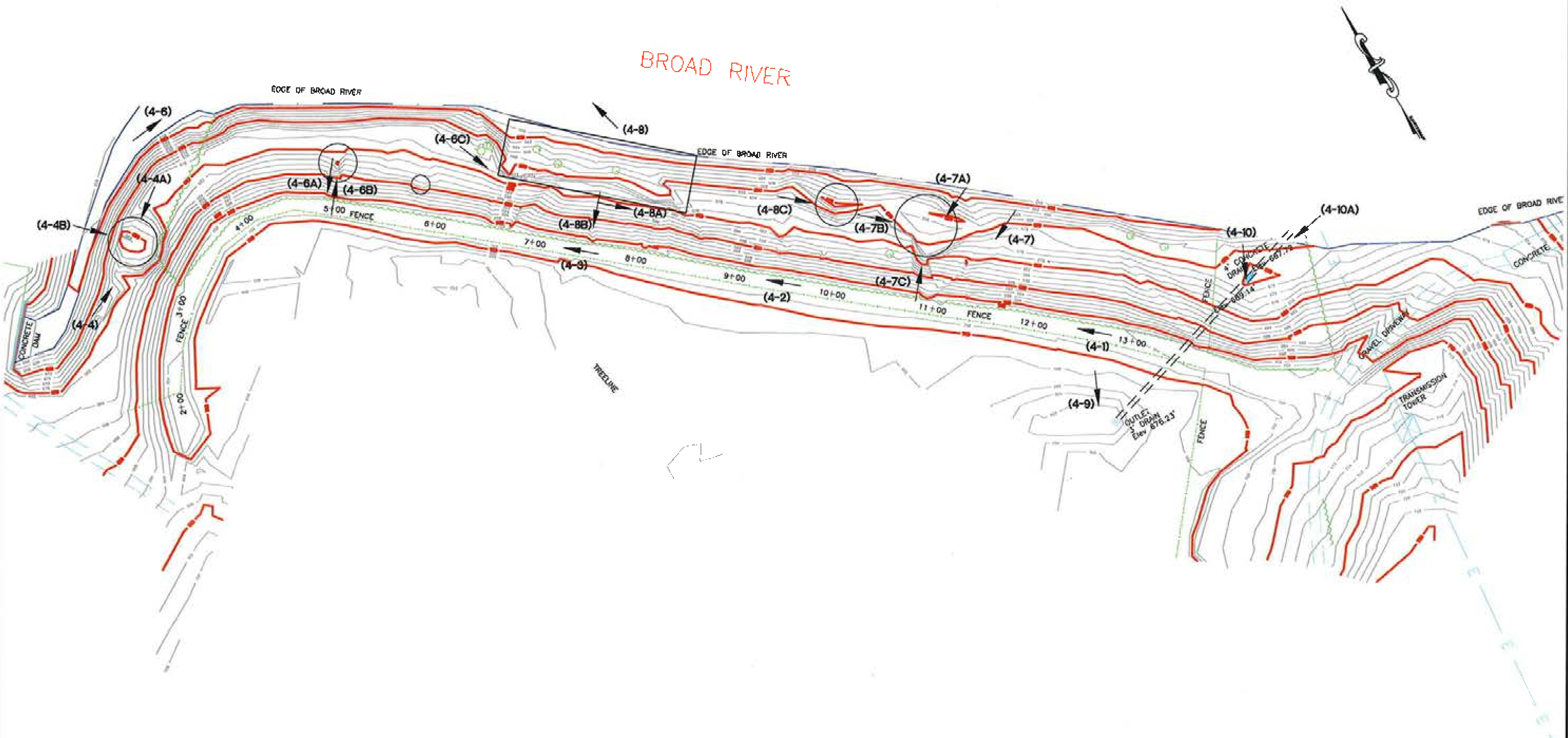
PLAN OF UNITS 1-4 OLD DIKE

CLIFFSIDE UNITS 1-4 OLD ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE 1-8-07	CHECKED MYB	DATE 1-8-07
JOB NO. 6234-06-3843		FIGURE	3



NOTES: ARROWS (——■—) SHOW APPROXIMATE DIRECTION OF VIEW OF PHOTOGRAPHS

APPROXIMATE AREAS OF OCTOBER, 2005 FAILURE/EROSION ON DOWNSTREAM SLOPE OF DIKE

100 50 0 100

APPROXIMATE SCALE IN FEET

REF.: SITE SURVEY PREPARED BY LATTIMORE & PEELER SURVEYING, DRAWING NOS. C#06-137C DATED 7/7/06. DIKE CENTERLINE STATIONS ADDED BY MACTEC.

MACTEC
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CHARLOTTE, NORTH CAROLINA

FAILED/ERODED AREAS OF UNITS 1-4 OLD DIKE

CLIFFSIDE UNITS 1-4 OLD ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE 1-8-07	CHECKED MPD	DATE 1-8-07
JOB NO.	6234-06-3843	FIGURE	3A

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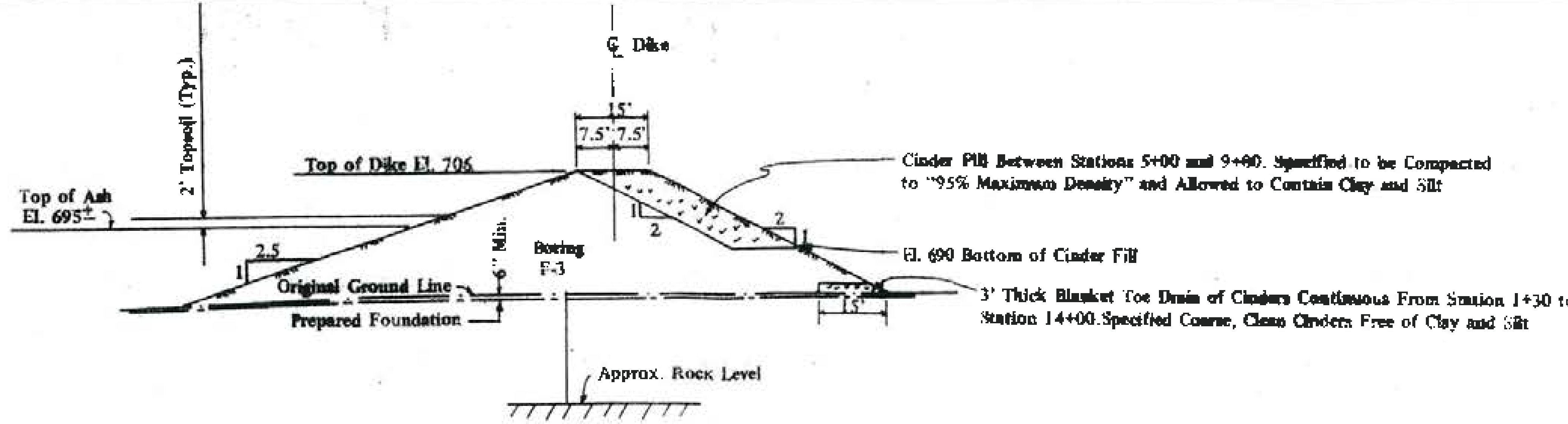
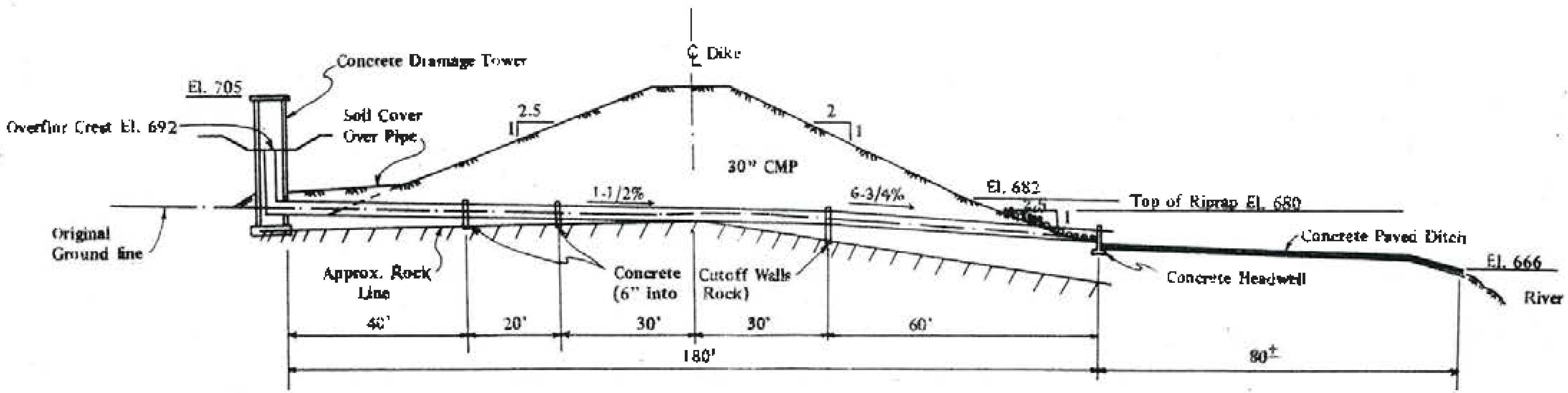


SECTION A-A

SCALE: 1"=30'



SECTION B-B

SCALE: 1"=30'

NOTE: SEE FIG. 3 FOR LOCATION OF SECTIONS

REF.: DUKE POWER COMPANY DRAWING NO. C-2004
(LAST REVISON DATED 6-30-77)

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SECTIONS THROUGH UNITS 1-4 OLD DIKE AND BASIN OUTLET
CLIFFSIDE UNITS 1-4 OLD ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE
MKH	1-8-07	MTB	1-8-07
JOB NO. 6234-06-3843		FIGURE 4	

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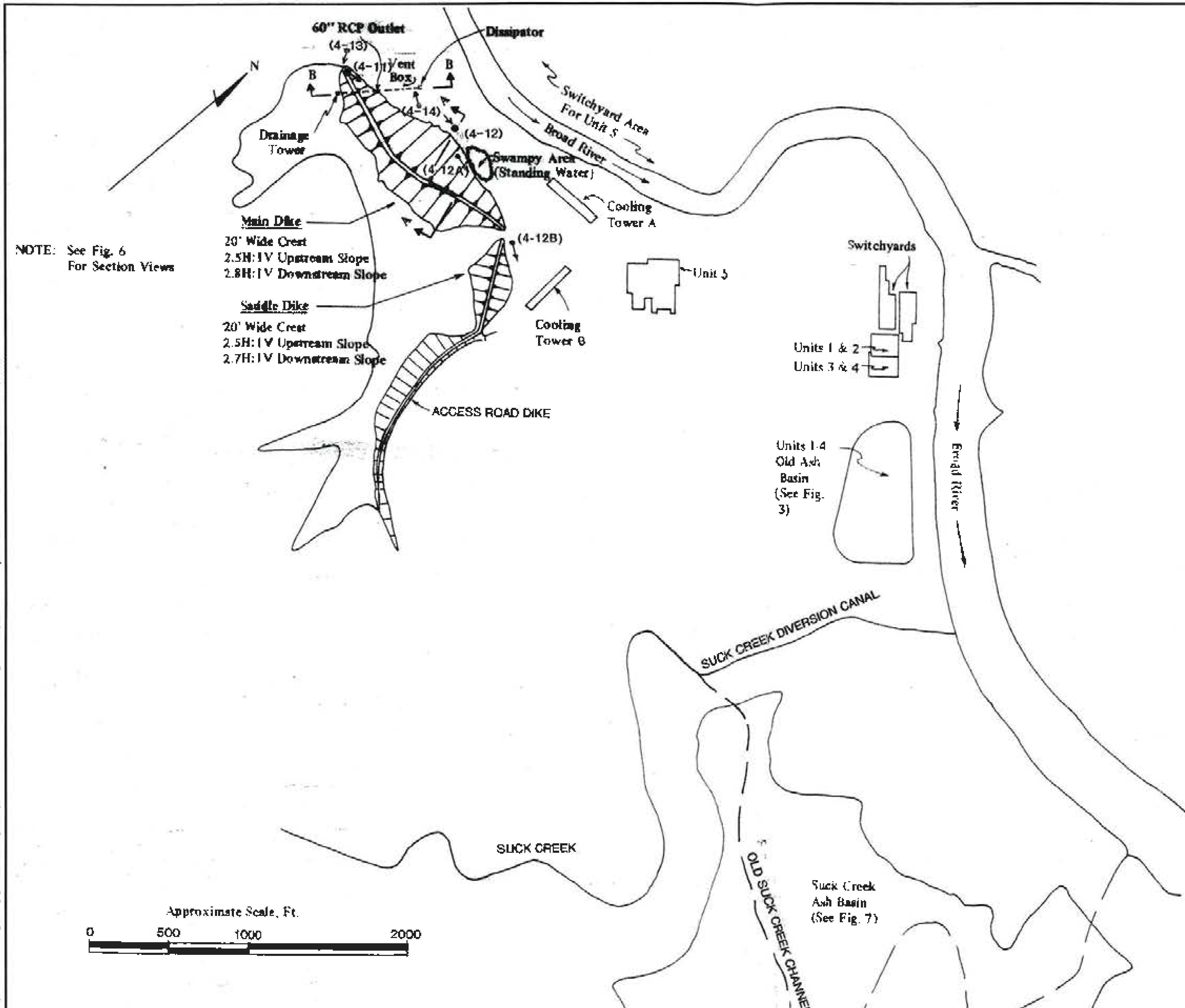


NOTE: See Fig. 6 For Section Views

NOTE: ARROWS (→) SHOW APPROXIMATE DIRECTION OF VIEW OF PHOTOGRAPHS

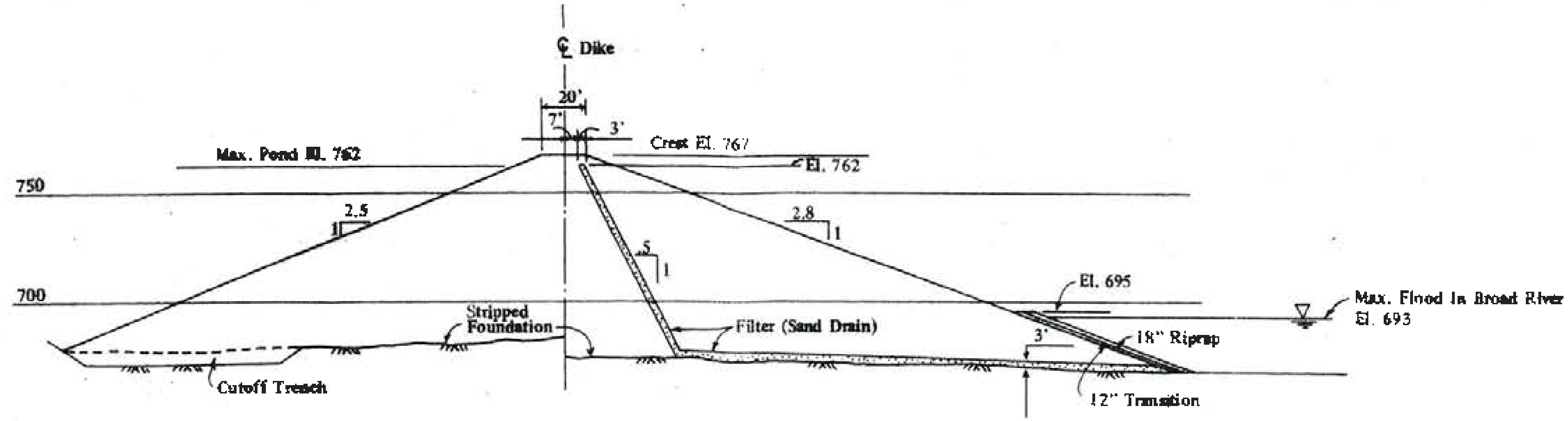
REF. DUKE POWER COMPANY DRAWING NO. C-3002 (BY BECHTEL CORPORATION)

MACTEC
ENGINEERING & CONSULTING, INC.
CHARLOTTE, NORTH CAROLINA

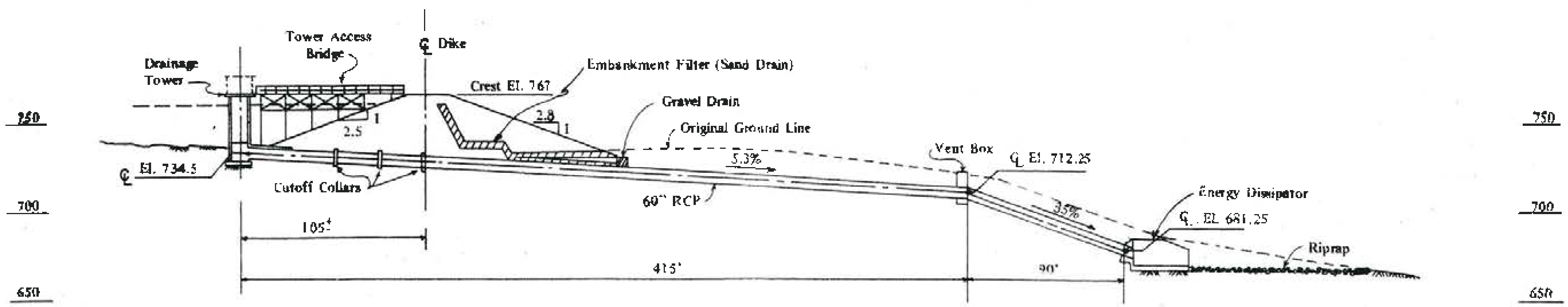
PLAN OF UNIT 5 OLD DIKES

CLIFFSIDE UNIT 5 OLD, ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE
[signature]	1-8-07	MYB	1-8-07
JOB NO.	6234-06-3843	FIGURE	5



SECTION A-A



SECTION B-B

NOTE: SEE FIG. 5 FOR LOCATION OF SECTIONS

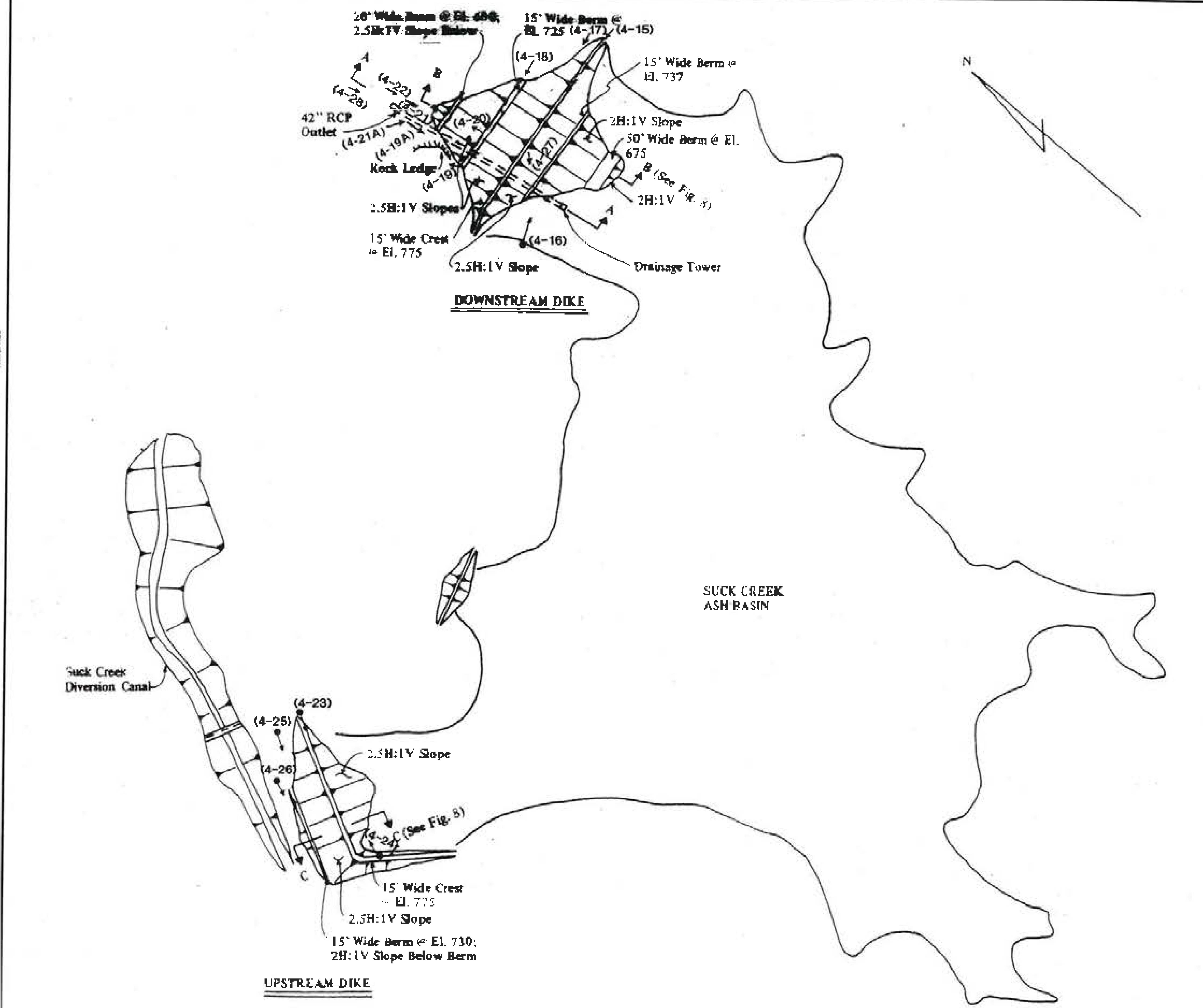
REF.: DUKE POWER DRAWING NOS. C-3037 (LASTEST REVISON DATED 7-24-77) AND C-3039 (LATEST REVISON DATED 6-5-70). (BOTH DRAWINGS BY BECHTEL CORPORATION)

P:\AutoCAD Drawings Only\Geotechnical\2006\6234-06-3843 Cliffside Storage Basin\Xsect2.dwg Tue, 09 Jan 2007 - 8:29am mharriso

MACTEC
ENGINEERING & CONSULTING, INC.
CHARLOTTE, NORTH CAROLINA

SECTIONS THROUGH UNIT 5 OLD MAIN DIKE AND BASIN OUTLET
CLIFFSIDE UNIT 5 OLD ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE
MCM	1-8-07	MTB	1-8-07
JOB NO. 6234-06-3843		FIGURE 6	



NOTE. ARROWS (●—►) SHOW APPROXIMATE DIRECTION OF VIEW OF PHOTOGRAPHS

REF. DUKE POWER COMPANY DRAWING NO. C-2015 (REVISON DATED 4-17-81)

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APPROX.SCALE,FT.

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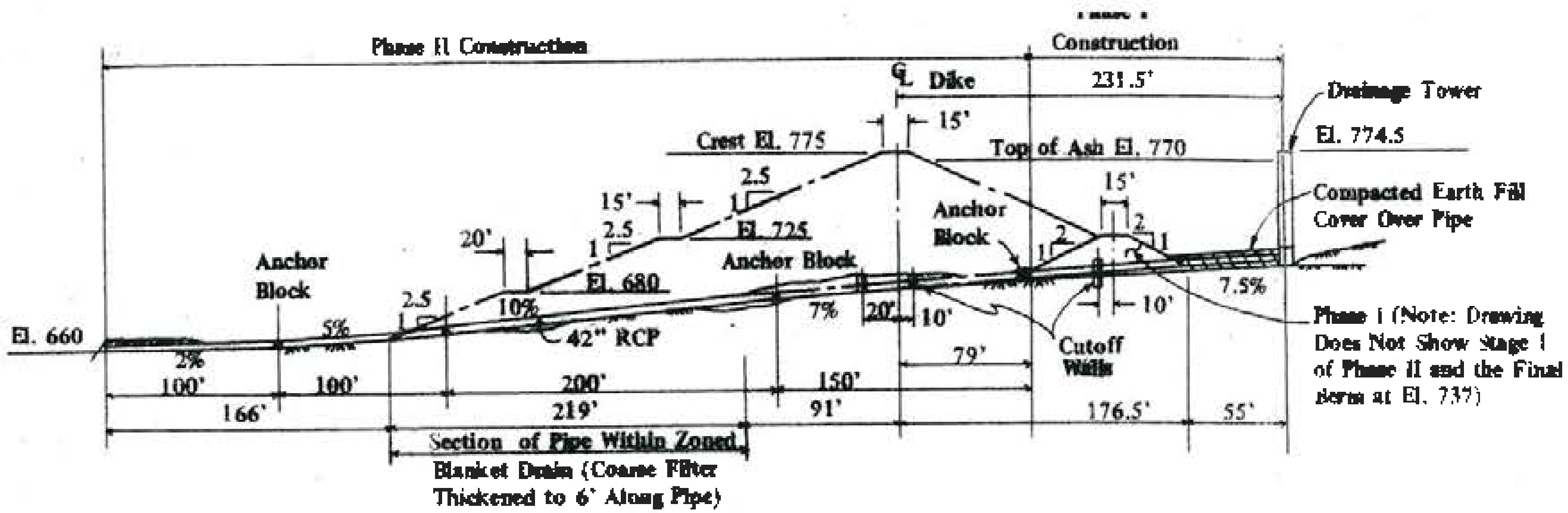
CHARLOTTE, NORTH CAROLINA

PLAN OF SUCK CREEK DIKES

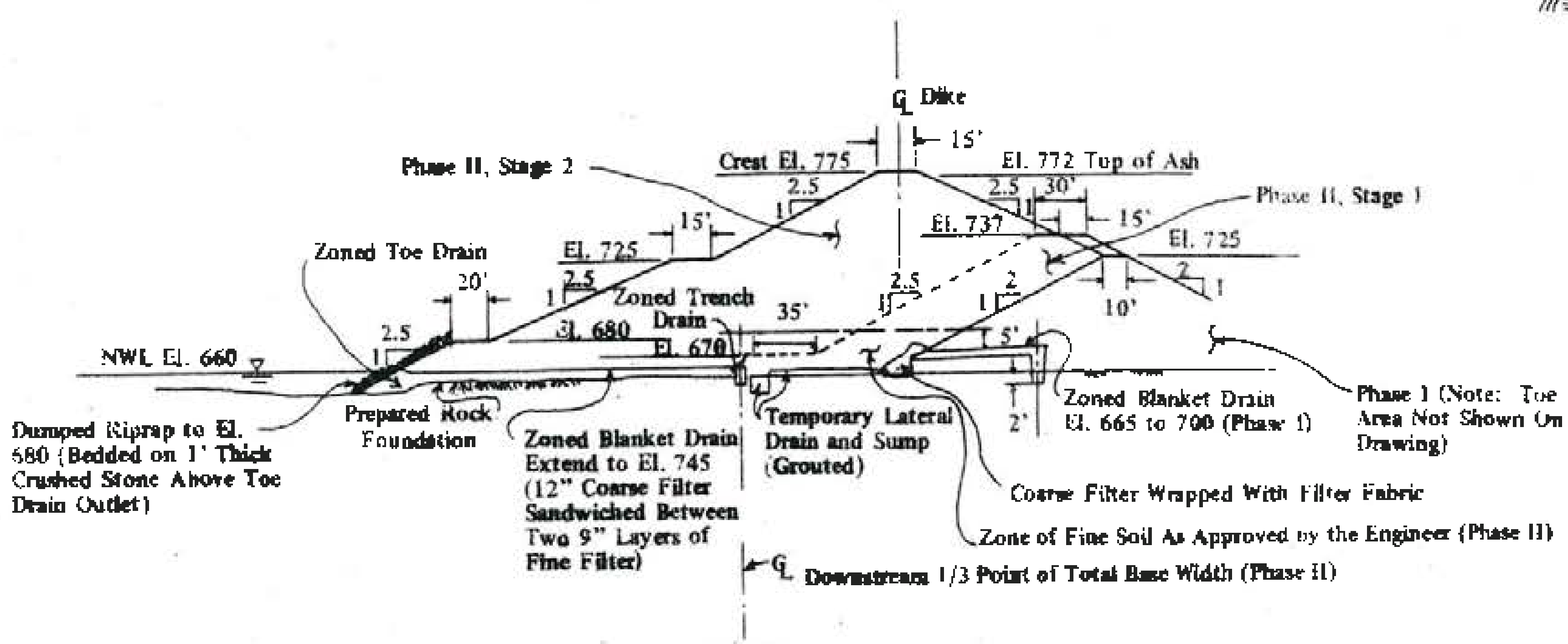
CLIFFSIDE UNITS 1-5 NEW ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE
[illegible signature]	1-8-07	MTB	1-8-07
JOB NO. 6234-06-0948		FIGURE 7	



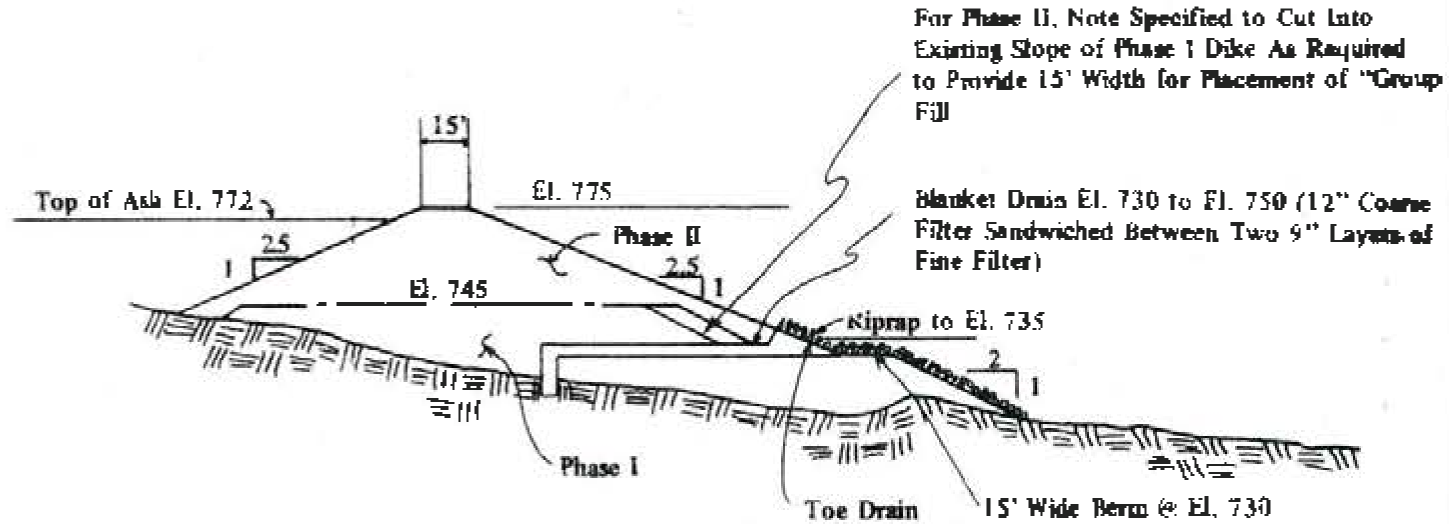
SECTION A-A

DOWNSTREAM DIKE AND OUTLET



SECTION B-B

DOWNSTREAM DIKE



SECTION C-C

UPSTREAM DIKE

NOTE: SEE FIG. 7 FOR LOCATION OF SECTIONS

REF.: DUKE POWER DRAWING NOS. C-2015A AND C-2015B (BOTH WITH LATEST REVISONS DATED 01/1981.

MACTEC
ENGINEERING & CONSULTING, INC.
CHARLOTTE, NORTH CAROLINA

SECTIONS THROUGH BUCK CREEK DIKES AND BASIN OUTLET

CLIFFSIDE UNIT 1-5 NEW ASH STORAGE BASIN
CLEVELAND COUNTY, NORTH CAROLINA

PREPARED BY	DATE	CHECKED	DATE
[illegible]	1-8-07	MYB	1-8-07
JOB NO.	6234-06-0948	FIGURE	8

P:\AutoCAD Drawings Only\Geotechnical\2006\6234-06-3843 Cliffside Storage Basin\Xsect3.dwg Tue, 09 Jan 2007 - 8:30am mhgriso

APPENDIX B

PHOTOGRAPHS

	Remarks
	Photograph 4-1 Crest of Units 1-4 old ash basin dike (E to W view). Depressions present in crest as in 2001 inspection, but obscured in photograph by high grass.

	Remarks
	Photograph 4-2 Crest of Units 1-4 old ash basin dike – undulations in fence unchanged from 2001.

	Remarks
	Photograph 4-3 Crest of Units 1-4 old ash basin dike (E to W view) west of undulating area. High grass obscures ground surface in photograph.

	Remarks
	Photograph 4-4 Outside (downstream) slope north end of Units 1-4 old ash storage basin area. Slope surface obscured by high grass.

	Remarks
	Photograph 4-4A Failed and eroded area of downstream slope and toe of Units 1-4 old ash basin dike, at about dike centerline station 3+00.

	Remarks
	Photograph 4-4B Failed and eroded area at station 3+00 viewed looking toward the Units 1-4 old ash basin dike centerline.

	Remarks
	Photograph 4-5 Tree growth obscures yard drainage holding pond and dredge spoil pond in Units 1-4 old ash basin area from viewpoint of 2001 inspection photograph.
	Remarks
	Photograph 4-5A Yard drainage holding pond and dredge spoil pond in Units 1-4 old ash basin area. Photographed from lower vantage point than photograph 4-5 to have somewhat less obstructed view.

	Remarks
	Photograph 4-6 Wooded outside (downstream) slope of Units 1-4 old ash basin dike. Note uncleared access road. Additional vegetation on access road compared to 2001 inspection.
	Remarks
	Photograph 4-6A Apparent old eroded/slump area on upper portion of downstream slope of dike, at approximately station 5+00, above the gully of Photograph 4-6B.

	Remarks
	Photograph 4-6B Eroded gully, about 5 ft deep, on downstream slope of Units 1-4 old ash basin dike, below upper slump/eroded area of photograph 4-6A.

	Remarks
	Photograph 4-6C Failed and eroded lower portion of downstream slope of Units 1-4 old ash basin, about 15 ft deep, extending from about station 6+50 to 8+50.

	Remarks
	Photograph 4-7 See photograph in 2001 Inspection Report.

	Remarks
	Photograph 4-7A See photograph in 2001 Inspection Report.

	Remarks
	Photograph 4-7B Approximately 20 ft deep failed and eroded area at downstream slope and toe of Units 1-4 old ash basin dike at about station 11+00.
	Remarks
	Photograph 4-7C Failed and eroded area of photograph 4-7B, viewed from above.

	Remarks
	Photograph 4-8 Drain pipes at edge of river below toe of outside slope of Units 1-4 old ash basin dike. Ground has eroded more below concrete since last inspection.
	Remarks
	Photograph 4-8A Failed and eroded lower downstream slope of Units 1-4 old ash basin dike at about station 8+00.

	Remarks
	Photograph 4-8B Apparent old slump/eroded area on upper portion of downstream slope of Units 1-4 old ash basin dike, above recent failure area of photograph 4-8A.

	Remarks
	Photograph 4-8C Failed and eroded lower downstream slope of Units 1-4 old ash basin dike, at about station 10+00.

	Remarks
	Photograph 4-9 View of Units 1-4 old ash basin drainage tower. High grass obscures the ground surface.

	Remarks
	Photograph 4-10 Outlet end of 30-inch CMP outlet for Units 1-4 old ash basin.

	Remarks
	Photograph 4-10A Severe erosion under and damage to concrete flume of 30 inch CMP outlet for Units 1-4 old ash basin.

	Remarks
	Photograph 4-11 Outside (downstream) slope of unit 5 retired basin main dike. Slope surface obscured by high grass.

	Remarks
	Photograph 4-12 Area of seepage and standing water at base of outside (downstream) slope of unit 5 retired basin main dike now covered by beaver pond.

	Remarks
	Photograph 4-12A Rip-rap covered downstream lower slope of outside (downstream) slope of unit 5 retired ash basin main dike. Note bushes and vegetation growing in rip-rap.

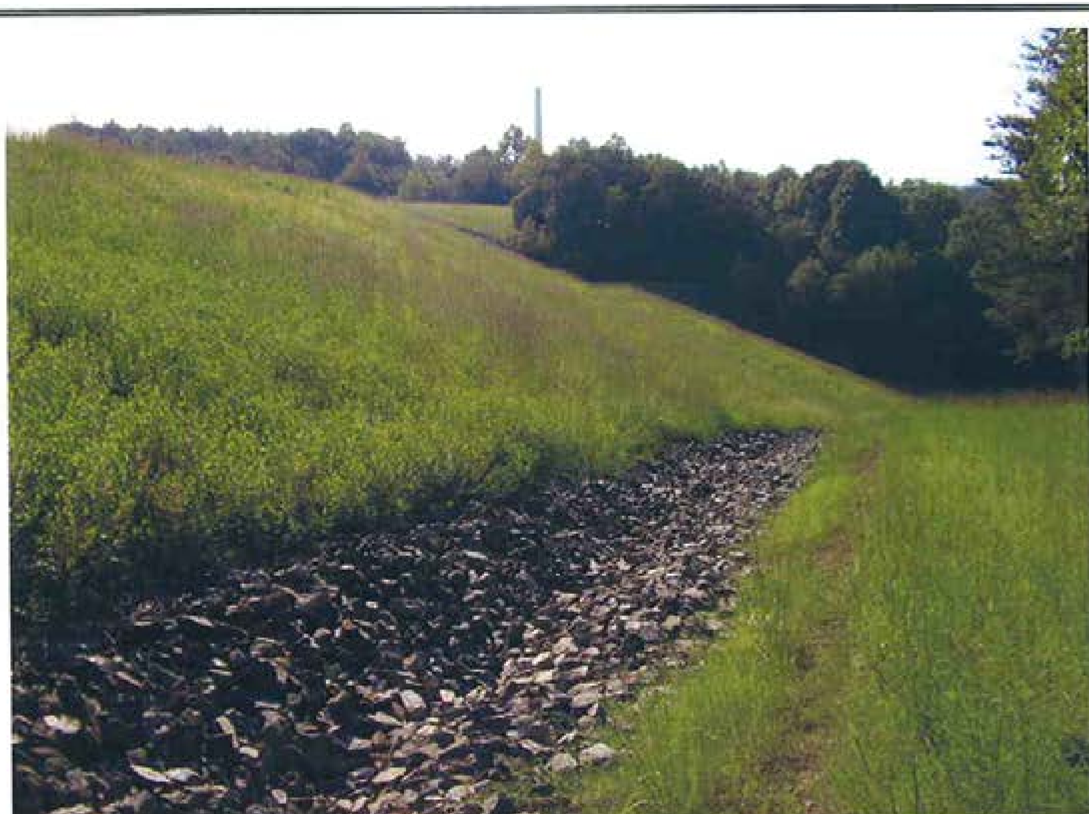
	Remarks
	Photograph 4-12B Downstream slope of saddle dike for unit 5 retired basin above cooling tower B. No seepage observed in overgrown low area. High grass obscures slope surface.

	Remarks
	Photograph 4-13 See photograph in 1991 Inspection Report.

	Remarks
	Photograph 4-14 Outlet end of 60-inch RCP outlet for unit 5 retired ash basin.

	Remarks
	Photograph 4-15 Crest of Suck Creek downstream dike (E to W view). Note high grass.

	Remarks
	Photograph 4-16 Inside slope of Suck Creek downstream dike (W to E view). High grass obscures the slope surface.

	Remarks
	Photograph 4-17 Outside slope of Suck Creek downstream dike (E to W view). High grass obscures the surface of slope and OW-10 and OW-11 on slope.

	Remarks
	Photograph 4-18 View of upper berm on outside slope of Suck Creek downstream dike (E to W view). High grass obscures the slope surface.
	Remarks
	Photograph 4-19 Rip-rap blanket over previously repaired slump. Soil erosion continues to occur at toe rip-rap. Note unmowed grass on slope.

	Remarks
	Photograph 4-19A Suck Creek downstream dike, left abutment contact. Weathered rock fallen into rip-rap lined ditch visible in 2001 photograph obscured by vegetation in 2006.

	Remarks
	Photograph 4-20 Rip-raped channel below toe of outside slope of Suck Creek downstream dike. High grass obscures slope surface and bottom of spillway channel.

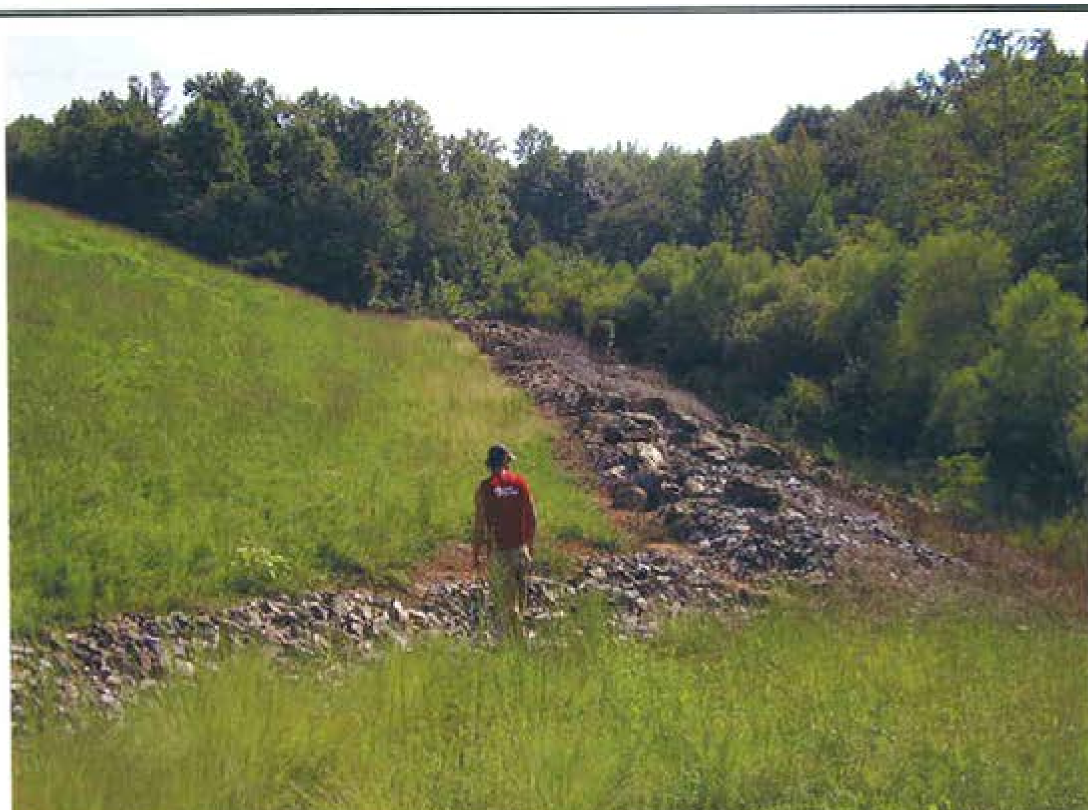
	Remarks
	Photograph 4-21 Toe of outside slope of Suck Creek downstream dike. Vegetation obscures area below toe of the rip-rap, in area of former beaver dam pool.

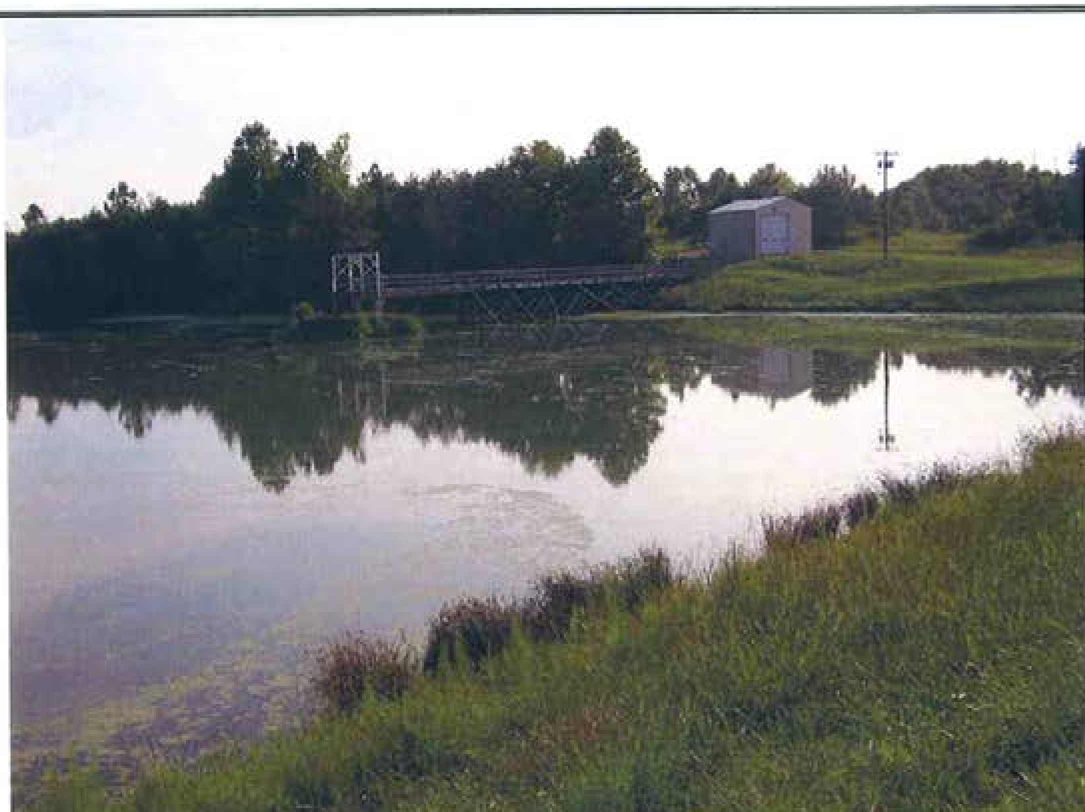
	Remarks
	Photograph 4-21A Right abutment rip-rap lined ditch viewed from toe. Note high grass on slope and in pool below toe of rip-rap.

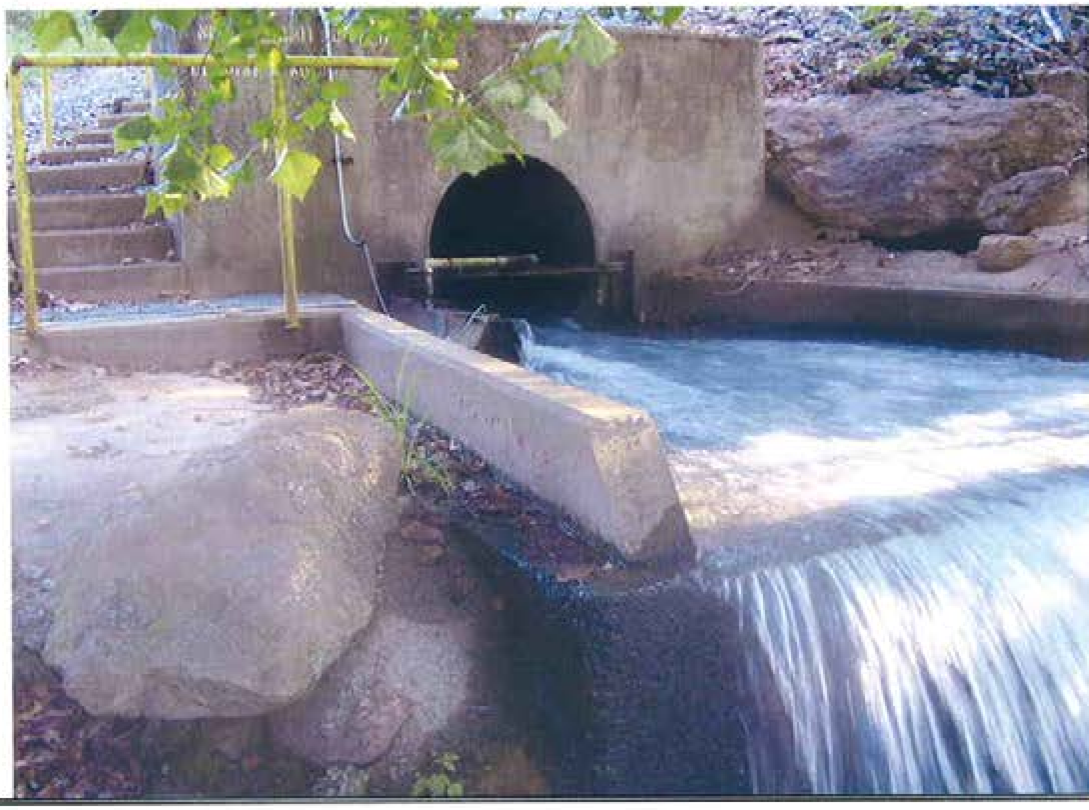
	Remarks
	Photograph 4-22 As in 2001, seepage emerging from under rip-rap at base of both left and right banks near upstream end of channel shown in Photographs 4-20 and 4-21. Note high grass in bottom of channel.

	Remarks
	Photograph 4-23 Crest of Suck Creek upstream dike (NE to SW view). High grass growth obscures the dike side slopes.

	Remarks
	Photograph 4-24 Inside slope of Suck Creek upstream dike (SW to NE view). Slope surface obscured by high grass.

	Remarks
	Photograph 4-25 Outside slope of Suck Creek upstream dike (NE to SW view). Area to right of rip-rap lined ditch was wet

	Remarks
	Photograph 4-26 Wet area beyond rip-rapped toe of outside slope of Suck Creek upstream dike. In 2001, area had been cleared of vegetation to approximately 15 ft from toe of rip-rap. Vegetation has become re-established within this 15 ft area in 2006.
	Remarks
	Photograph 4-27 View of Suck Creek ash basin drainage tower.

	Remarks
	Photograph 4-28 Outlet end of 42-inch RCP outlet for Suck Creek ash basin.

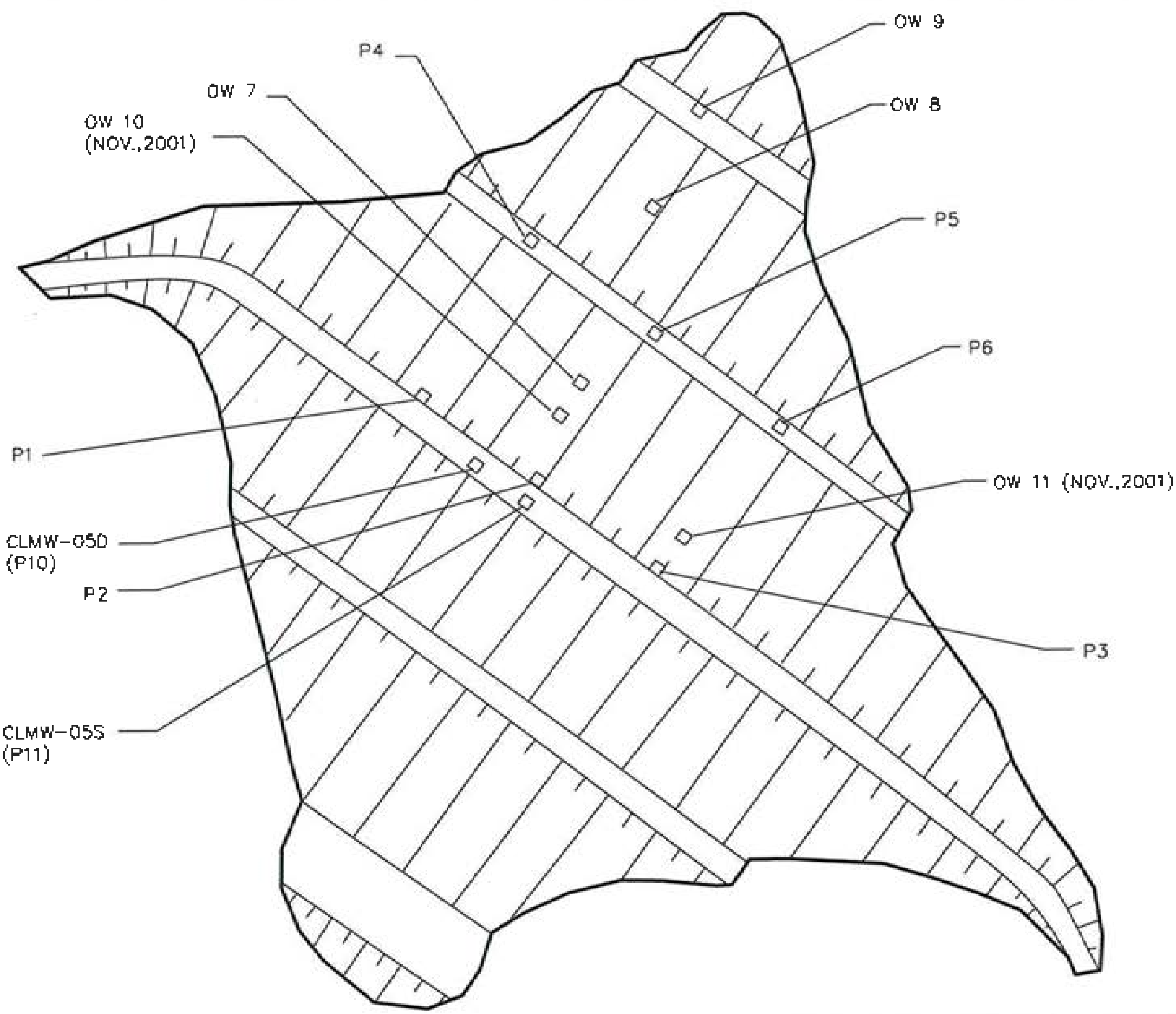
APPENDIX C

MONITORING DATA

TABLE C-1
SUMMARY OF READINGS
MACTEC Project No. 6234-06-3843

		Analysis Phreatic Elevation		Highest Reading/Date/Pond Elevation
Piezometer or OW	Measuring Interval	1983	1997	
P1	725-735	763		740 / (mid 2003) / 762
P2	723-730	763	764	745 / (early 2006) / 765
P3	723-730	763		750 / (early 2006) / 765
P4	686-691	687 (blanket)		687*
P5	682-689	664 (blanket)	702	686*
P6	686-	688 (blanket)		687*
OW7	711-741	724	735	732 / 1993 / 758
OW8	661.8-695	659.8 (blanket)	676	664*
OW9	661-675	658.5 (blanket)	670	664*
.OW10	707-749	---	748	731 / (early 2006) / 765
.0W11	714-766	---	760	731 (early 2002) / 762
P10	660-683	766	766	715 / 2000 / 762
P11	715-727	766	766	746 / (early 2006) / 765
Pond		772	772	765 / (early 2006)

* These readings have remained generally unchanged, with little fluctuation, since installation of these instruments.



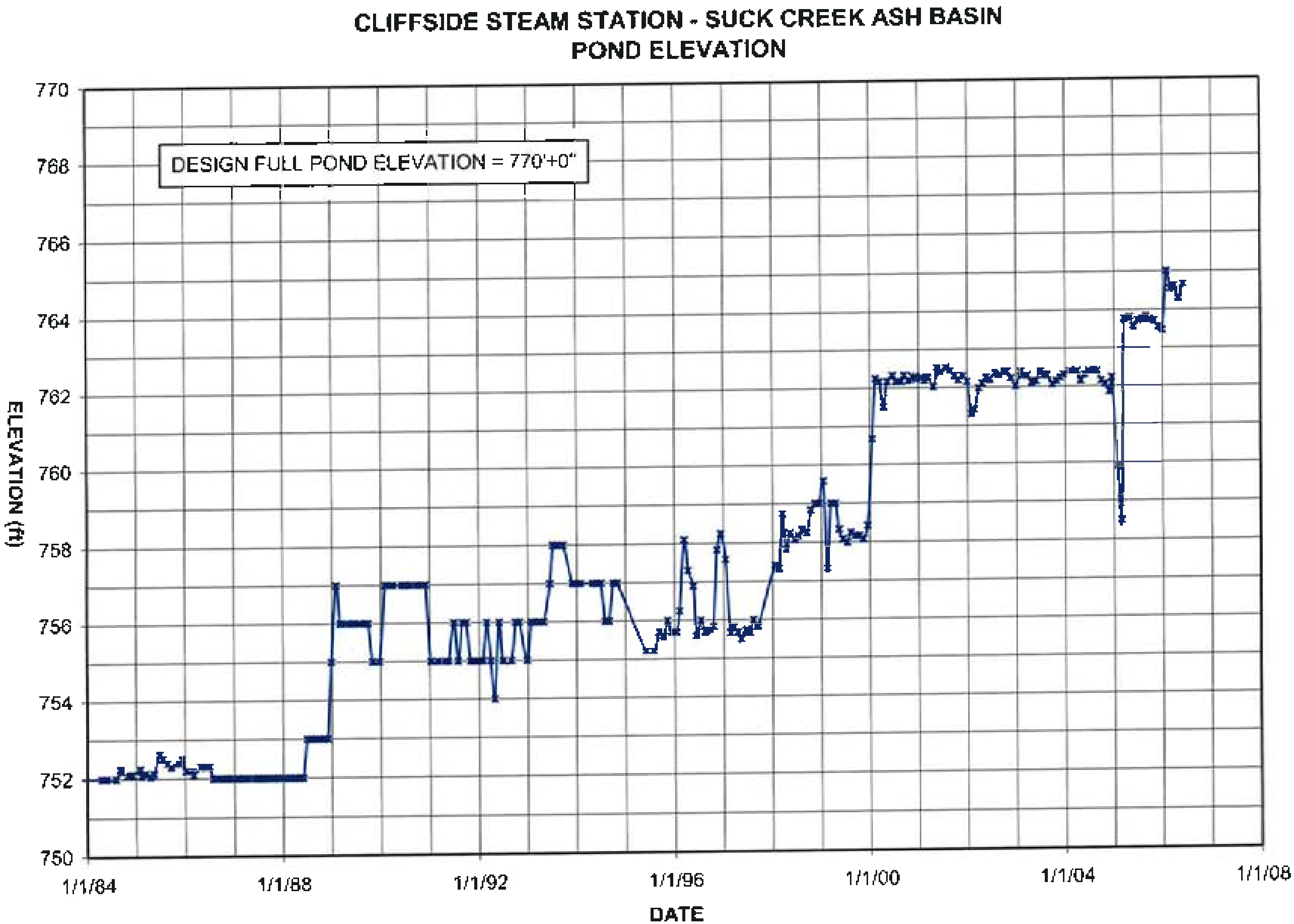
EXPLANATION

□ APPROXIMATE PIEZOMETER LOCATION
P1

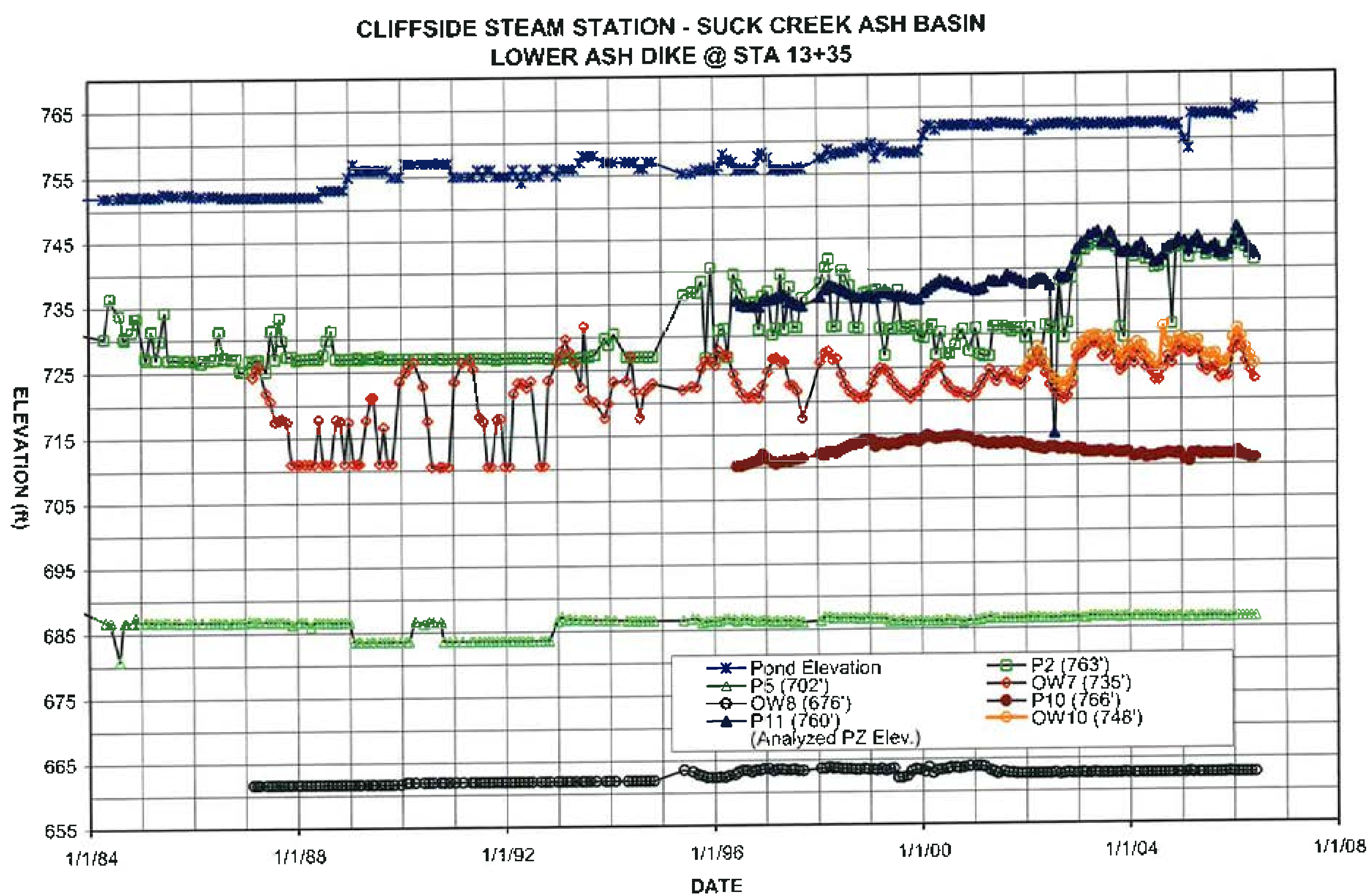
□ APPRXIMATE OBSERVATION WELL LOCATION
OW-7

MACTEC ENGINEERING & CONSULTING, INC. CHARLOTTE, NORTH CAROLINA		PIEZOMETERS AND OBSERVATION WELLS CLIFFSIDE STEAM STATION SUCK CREEK DOWNSTREAM ASH DIKE	
PREPARED BY [signature]	DATE 7-8-07	JOB NO. 6234-06-3843	FIGURE C-2
CHECKED MTB	DATE 7-8-07		

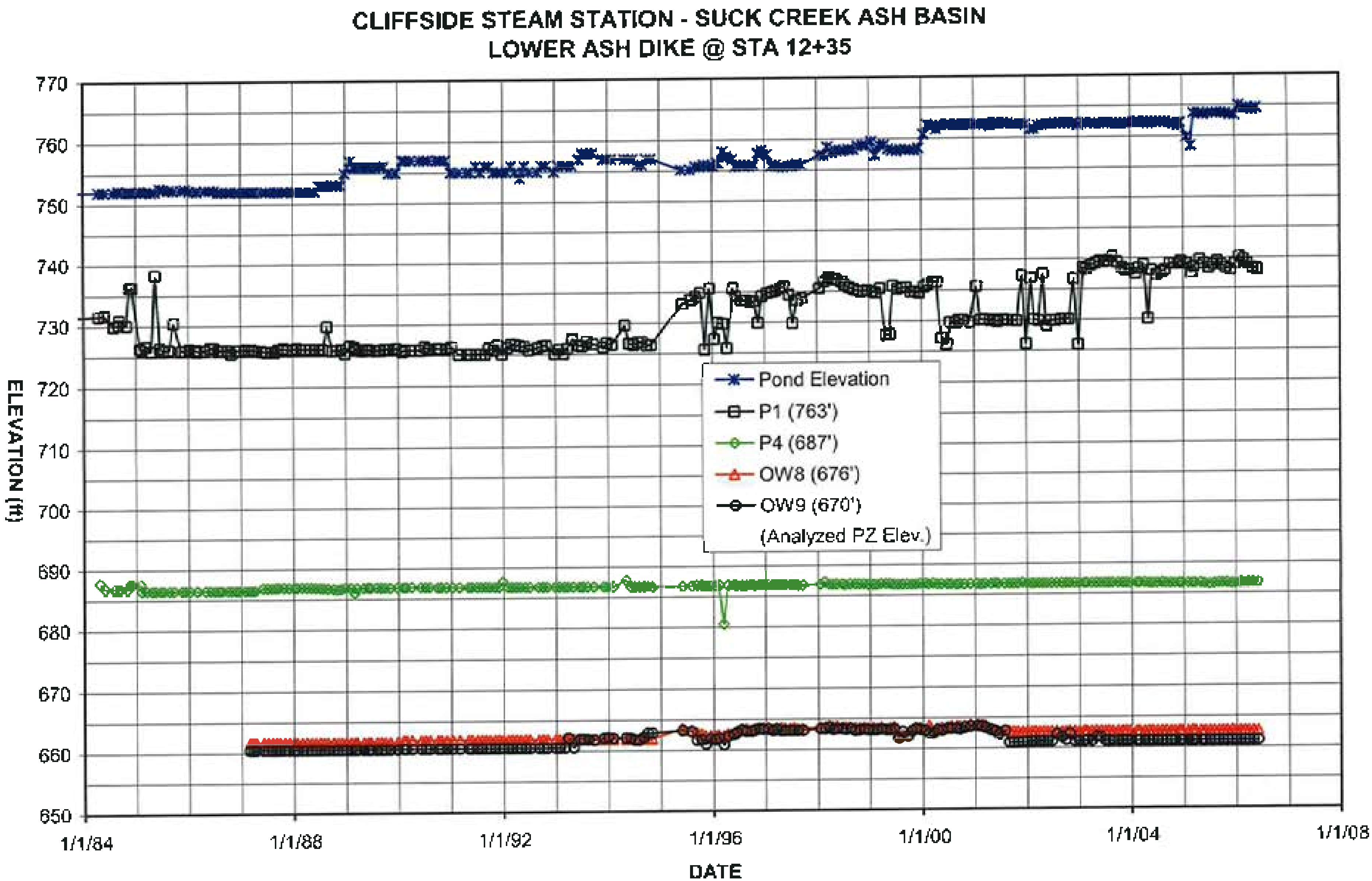
G:\PROJECTS\30120 GEOTECHNICAL\2001\0948\PIEZOMETER.dwg 12/05/01 MHARRISON



CS Piezometers (5-31-06).XLS

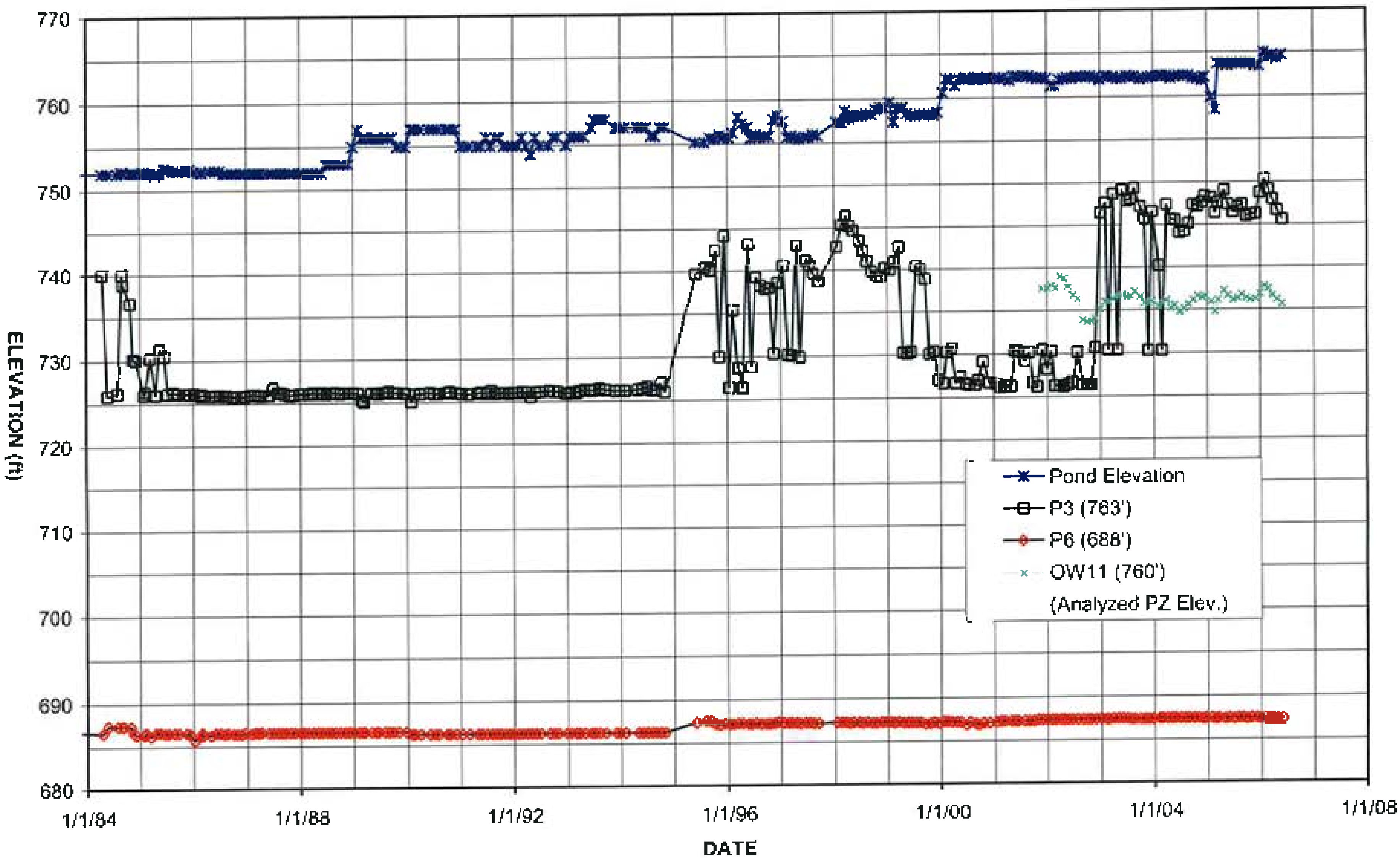


CS Piezometers (5-31-06).XLS



CS Piezometers (5-31-06).XLS

CLIFFSIDE STEAM STATION - SUCK CREEK ASH BASIN
LOWER ASH DIKE @ STA 14+35



CS Piezometers (5-31-06).XLS

Duke Energy.

DUKE ENERGY CORPORATION
WP994 1000 East Main Street
Plainfield IN 46168-1782

Via Certified Mail 7008 2810 0000 0830 9260

March 25, 2009

Mr. Richard Kinch
US Environmental Protection Agency (5306P)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

RE: CERCLA 104(e) Request for Information
Cliffside Steam Station
573 Duke Power Road
Mooresboro, North Carolina 28114

Dear Mr. Kinch,

Duke Energy Carolinas, LLC (DEC) hereby responds to the request for information the EPA submitted to the Cliffside Steam Station, letter dated March 9, 2009, under Section 104(e) of CERCLA, 42 USC § 9604(e), relating to surface impoundments or similar diked / bermed management units which receive liquid-borne material for storage or disposal of residuals or by-products from the combustion of coal. DEC received this request on March 12, 2009, and today's response complies with the 10-business day deadline.

The attached responses are full and complete and were developed under my supervision with assistance from Duke Energy's Engineering and Technical Services group. The following clarifications should be noted for the attached responses.

- The responses in this submittal are for surface impoundments and the associated secondary / clarifying ponds used for temporary or permanent storage of flyash, bottom ash, boiler slag, and flue gas emission control residues at this station (hereinafter "coal combustion by-products").
  - These ponds are also an integral part of the station's wastewater treatment system used to manage wastewater before discharge.
- The response to the questions does not include ponds that are retired / closed and which no longer contain free liquids.
- The response to questions does not include landfill runoff collection ponds or any other miscellaneous ponds / impoundments that are not designed to or do not regularly receive and store coal combustion by-products.
- Where actual measurements could not be collected within the timeframe allotted by EPA, DEC has provided estimates, which are noted as such.
- The criteria that DEC used to identify any spills or unpermitted releases over the last 10 years in the response to Question #9 include the failure of physical pond or impoundment structures (i.e. berms, dikes, and discharge structures); the criteria do not include exceedances of the NPDES discharge limits that have already been reported in the discharge monitoring report.

I certify that the information contained in this response to EPA's request for information and the accompanying documents is true, accurate, and complete. As to the identified portions of this response for which I cannot personally verify their accuracy, I certify under penalty of law that this response and all attachments were prepared in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

If you have any questions regarding today's submittal please contact Richard Meiers at our corporate offices at 317-838-1955.

Sincerely,
Duke Energy Carolinas, LLC

BEPulskamp

Barry E. Pulskamp
Senior Vice President Regulated Fleet Operations

Attachments (3)

Responses to Enclosure A
Inspection Report
Confidential Business Information

cc Rick R. Roper
Cliffside Steam Station
General Manager II Regulated Fossil Fleet
Steve Hodges
Senior EHS Professional
Richard J. Meiers
Principal Environmental Scientist

Attachment # 1

Response to Questions in Enclosure A

Cliffside Steam Station

March 25, 2009

1. Relative to the National Inventory of Dams criteria for High, Significant, Low, or Less than Low Hazard Potential, please provide the rating for each management unit and indicate which State or federal regulatory agency assigned that rating. If the unit does not have a rating, please note that fact.

> No State or Federal regulatory agency has assigned a rating relative to the National Inventory of Dams criteria for the management unit at Cliffside Steam Station; however, the North Carolina Utilities Commission has classified it as low hazard under the NC Dam Safety Rules due to the lack of downstream development.

2. What year was each management unit commissioned and expanded?

> Primary Active Ash Pond was commissioned in 1983

3. What materials are temporarily or permanently contained in the unit? Use the following categories to respond to this question: (1) fly ash; (2) bottom ash; (3) boiler slag; (4) flue gas emission control residuals; (5) other. If the management unit contains more than one type of material, please identify all that apply. Also, if you identify "other," please specify the other types of materials that are temporarily or permanently contained in the unit(s).

Management Unit	Active Pond	Retired Unit 1-4 Basin**	Retired Unit 5 Basin***
Contents	1, 2, 3, 4, 5*	5	5

* "Other" includes water treatment, boiler blow down, floor and laboratory drains and drains from equipment cleaning, cooling tower blow down, boiler chemical cleaning wastes, storm water runoff, coal pile runoff, and fire protection, and mill rejects.

** This closed ash basin is now used to transfer liquids from yards and plant sump drains to the Active Pond.

*** A section of this closed ash basin is used for erosion control sediment pond for new construction

4. Do you have a Professional Engineer's certification for the safety (structural integrity) of the management unit(s)? Please provide a copy if you have one. If you do not have such a certification, do you have other documentation attesting to the safety (structural integrity) of the management unit(s)? If so, please provide a copy of such documentation.

It is a North Carolina Utilities Commission (NCUC) requirement from 1976 to have an inspection performed every 5 years by an independent consultant who uses a qualified licensed professional engineer. Per NCUC Docket No. E-100, Sub 23, routine inspections are done to assure structural integrity. The most recent report is attached (Attachment 2).

5. When did the company last assess or evaluate the safety (i.e., structural integrity) of the management unit(s)?

The management units listed in the response to question #2 was last inspected in September, 2006.

Briefly describe the credentials of those conducting the structural integrity assessments/evaluations.

MACTEC is an industry leader in engineering, environmental, and construction services to public and private clients worldwide. Based in Atlanta, MACTEC includes 3,000 employees in 80 locations.

Identify actions taken or planned by facility personnel as a result of these assessments or evaluations.

See attached inspection report (Attachment 2). Typical findings that require corrective actions are: Treat excess vegetation, clear ditch line of sediment and debris, re-seed sparsely vegetated and disturbed areas, or mow slopes in a diagonal pattern running transverse to existing rut lines. Other more site specific maintenance items are detailed in the reports.

If corrective actions were taken, briefly describe the credentials of those performing the corrective actions, whether they were company employees or contractors.

See attached Inspection report (Attachment 2). Duke Energy's Generation Engineering Department provides engineering oversight, review, and documentation of maintenance done and repairs made. The inspection report and corrective actions are filed with the NCUC.

If the company plans an assessment or evaluation in the future, when is it expected to occur?

Duke Energy Carolinas' inspection program requires an annual inspection. We may do these in-house by qualified personnel or we may elect to contract the annual inspections.. Monthly visual inspections are conducted by Duke Energy personnel. A visual inspection is also conducted after a significant rainfall. The next 5-year independent inspection will be completed in 2011.

6. When did a State or a Federal regulatory official last inspect or evaluate the safety (structural integrity) of the management unit(s)? If you are aware of a planned state or federal inspection or evaluation in the future, when is it expected to occur? Please identify the Federal or State regulatory agency or department which conducted or is planning the inspection or evaluation. Please provide a copy of the most recent official inspection report or evaluation.

> The North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Quality and Division of Land Quality staff inspected Cliffside Steam Station's Ash basins on January 13, 2009. There were no issues or deficiencies identified in the inspection report from NCDENR dated March 19, 2009. No other State or Federal regulatory officials have performed ash pond dike inspections in the last five years. DEC is not aware of any federal or state agency inspection reports. It is a North Carolina Utilities Commission (NCUC) requirement from 1976 to have an inspection performed every 5 years by an independent consultant who uses a qualified licensed professional engineer. The last such inspection occurred in September, 2006. The next such inspection will occur in 2011.

7. Have assessments or evaluations, or inspections conducted by State or Federal regulatory officials conducted within the past year uncovered a safety issue(s) with the management unit(s), and, if so, describe the actions that have been or are being taken to deal with the issue or issues. Please provide any documentation that you have for these actions.

> DEC is not aware of any safety issues discovered as a result of any assessments, evaluations, or inspections conducted by State or Federal regulatory officials at the Cliffside Steam Station within the past year.

8. What is the surface area (acres) and total storage capacity of each of the management units? What is the volume of material currently stored in each of the management unit(s). Please provide the date that the volume measurement was taken.

> The response to this question contains Confidential Business Information, which is of a competitive and commercial nature, pursuant to 40 C.F.R. Part 2. Our response is therefore provided in a separate attachment (Attachment 3), which has been labeled "CBI." DEC requests that EPA treat the information in Attachment 3 as CBI and safeguard it from inadvertent disclosure and contact DEC if EPA receives a request for this CBI.

9. Please provide a brief history of known spills or unpermitted releases from the unit within the last ten years, whether or not these were reported to State or federal regulatory agencies. For purposes of this question, please include only releases to surface water or to the land (do not include releases to groundwater).

On October 7, 2005 the Cliffside Steam Station experienced a significant localized flood event. The floodwaters from the Suck Creek entered into the retired Units 1-4 ash basin, topped the top of the dam and washed away part of the basin's dike. Notifications were made to the North Carolina Division of Water Quality. The dike was repaired. There have been no other spills or unpermitted releases from any of the management units listed in response #2 over the past ten years.

10. Please identify all current legal owner(s) and operator(s) at the facility.

Duke Energy Carolinas, LLC is the legal owner and operator at the facility.

Attachment #3

CBI

This attachment contains Confidential Business Information, which is of a competitive and commercial nature, pursuant to 40 C.F.R. Part 2. DEC requests that EPA treat the information in Attachment 3 as CBI and safeguard it from inadvertent disclosure and contact DEC if EPA receives a request for this CBI.

Cliffside Steam Station
Response to Question # 8

Active Pond

- 84 acres in total surface area with 5,025 acre/feet of total storage volume
- The station estimated in January 2009 that the pond was approximately 80% full
    - The ash basin maintains at least a capacity for free water volume that is sufficient to handle maximum 24 hour flows including a 10 year 24 hour rainfall event.

Retired Unit 5 Basin

- This basin was 46 acres but has been closed and covered with soil; a section is used for erosion control sediment pond for new construction.

Retired Units 1-4 Basin

- 14 acres in total surface area with no available ash storage area. This pond is used to transfer liquids from yards and plant sump drains to active ponds

10/12/81

LAW ENGINEERING
TESTING COMPANY

Report of Safety Inspection
Duke Power Cliffside Steam Station Ash Dikes
Cleveland and Rutherford Counties, North Carolina
LETCo. Job No. CH 4581

LAW ENGINEERING TESTING COMPANY
geotechnical, environmental & construction materials consultants
501 MINUET LANE
P.O. BOX 11297 • CHARLOTTE, NORTH CAROLINA 28220
(704) 523-2022

October 12, 1981

Duke Power Company
Civil/Environmental Division
P. O. Box 33189
Charlotte, North Carolina 28242

Attention: Mr. S. B. Hager, Chief Engineer

Subject: Report of Safety Inspection
Duke Power Cliffside Steam Station Ash Dikes
Cleveland and Rutherford Counties, North Carolina
LETCo. Job No. CH 4581

Gentlemen:

Law Engineering Testing Company is pleased to submit the following report of our safety inspection of the ash retention dikes at the Cliffside Steam Station. The study was performed in accordance with our letter dated April 15, 1981, and was authorized by your letter of May 1, 1981. The safety inspection was made to comply with the North Carolina Utilities Commission Order, Docket No.: E-100, Sub. 23, which requires each North Carolina Electric Utility Company to schedule periodic inspection, by an independent consultant, of each dam owned in North Carolina and not covered by the North Carolina Dam Safety Law, NSCG 143-215 or by the Federal Power Commission license. The inspection was done in the fifth year of Duke Power's initial five-year plan for independent consultant inspection.

Our field inspection found no external, presently visible, signs of deep-seated instability of the ash retention dikes at the Cliffside plant. Our hydrologic analyses indicate that the dikes should have adequate hydrologic safety. The results of the field inspection, as well as office review of available engineering data and historic information, indicate no cause for additional study of structural stability or hydrologic safety of the dikes at this time. No remedial action on the dikes appears warranted, other than routine maintenance and inspections.

We appreciate the opportunity to provide our professional services to you on this project. Please let us know if you have any questions regarding this report.

Very truly yours,

LAW ENGINEERING TESTING COMPANY

Fred C. Tucker, P. E.
Project Soils Engineer
Registered, N. C. 8150

Clay E. Sams, P. E.
Vice President
Soils Consultant
Registered, N. C. 4459

FCT/CES/etw

Attachments

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PHOTOGRAPHS

DUKE POWER COMPANY
CLIFFSIDE STEAM GENERATING STATION
CLEVELAND AND RUTHERFORD COUNTIES
NORTH CAROLINA

SAFETY INSPECTION OF ASH DIKES

by

LAW ENGINEERING TESTING COMPANY
CHARLOTTE, NORTH CAROLINA
LETCo. JOB NO. CH 4581
OCTOBER, 1981

INTRODUCTION

Subject Facilities

This safety inspection report covers three separate ash retention facilities at Duke Power Company's Cliffside Steam Station, as follows:

1) the Units 1-4 old ash basin dike;
2) the Unit 5 old ash basin dikes;
3) the Suck Creek new ash basin dikes for Units 1-5.

These ash retention facilities are owned by Duke Power Company and have been since their construction. Mr. M. I. Moser has overall responsibility for general maintenance and upkeep as plant superintendent at the Cliffside Station.

Field inspection of the ash retention dikes was done on June 22, 1981, by our Mr. F. C. Tucker, P. E., in company with Duke's Messrs. T. A. Propst and E. F. Smith from Design, Mr. L. J. Starnes from Station Support, and Mr. R. L. Roberts from Steam Production. Dry weather conditions prevailed during the inspection.

Purpose and Scope

The purpose of this dike inspection and report is to identify any hazards to human life and property within the limitations of surficial field inspection and office review of available data, records and operating history. The objective is to recommend immediate action for public protection where necessary, further studies and analyses where required, and acceptance of the present condition of the dikes if the engineering data and inspections so justify.

A review was made of pertinent existing and readily available engineering data relative to the design, construction and operation of the ash retention dikes and outlet works. A detailed systematic visual inspection was performed of those visible features relating to the stability and operational adequacy of the earth dikes. Approximate hydrologic analyses were made. Based upon results of the above work, an engineering opinion is given of the general condition of the dikes, including the hydrologic capabilities and the structural stability.

The purpose and scope of this study are consistent with that outlined in Law Engineering's letter of April 15, 1981, and with Phase I Investigations of the "Recommended Guidelines for Safety Inspection of Dams", originally released by the Department of the Army, Office of the Chief of Engineers, in May 1976, with the latest updates included.

Authorization

This Phase I Investigation was authorized by Messrs. S. B. Hager, Chief Engineer, and J. P. Bultman, Sr., Principal Engineer, of Duke's Civil/Environmental Division, in their letter dated May 1, 1981.

LOCATION

The Duke Power Company's Cliffside Steam Station is located approximately 55 miles west of Charlotte and about 1.5 miles south of the small town of Cliffside, North Carolina. The power plant site is situated primarily on the south side of the Broad River and straddles the Cleveland/Rutherford County line. The Units 1-4 old ash basin and the Suck Creek new ash basin lie southeast of the Units 1-4 powerhouse in Cleveland County; the Unit 5 old ash basin lies southwest of the Unit 5 powerhouse in Rutherford County. Figures 1 and 2 show the locations of the ash basins on a North Carolina Road Map (1976) and the Cowepens, South Carolina/North Carolina (1959) USGS quadrangle sheet, respectively.

GENERAL GEOLOGY

The Cliffside ash storage basins lie within the Central Piedmont Physiographic Province, an area characterized by ancient igneous and metamorphic rocks which have been weathered in-place to form a mantle of residual soils. Geologic literature indicates that the Cliffside area is underlain predominantly by metamorphic rocks, gneiss and schist, with occassional intrusions of igneous rocks such as granite. Pegmatite intrusions are found in the area. The rocks have been folded and contorted and thus contain many structural features.

CLIFFSIDE UNITS 1-4

OLD ASH BASIN DIKE

CLIFFSIDE UNITS 1-4 OLD ASH BASIN DIKE

Description

Physical Characteristics - The pertinent physical and geometric features of the Cliffside Units 1-4 old ash basin dike are shown on Figures 3 and 4. These figures and the following descriptions are based on copies of Duke's Drawing Nos. C-2004 through C-2006 (all with latest revisions dated June 30, 1977), C-2007 (latest revision dated January 28, 1970) and C-2011 (latest revision dated June 10, 1958).

This old dike is an L-shaped earthfill embankment which was constructed adjacent to the Broad River as shown in plan view on Figure 3. Overall length of the dike is about 1480 ft along the crest. The dike was designed to have a 15-ft wide crest at elevation 706 feet. Maximum height of the dike is about 38 ft above the downstream toe. Design drawings called for a 2.5H:1V upstream slope and a 2H:1V downstream slope to elevation 682 ft, then 2.5H:1V slope below 682 ft to the downstream toe.

The downstream toe of the dike was designed to have internal drainage consisting of a 3-ft thick, 15-ft bottom width blanket toe drain of clean coarse cinders extending practically full length of the dike. The downstream toe was to be covered with a 9-inch minimum thickness blanket of riprap (not visible in our inspection) extending upslope to elevation 680 feet. A 400-ft long portion of the dike was to contain cinders (with clay and silt) in a 15-ft wide zone beneath the downstream slope from the crest to elevation 690 ft (see Section A-A, Figure 4).

The outlet for the ash basin is a reinforced concrete drainage tower with bottom discharge into a 30-inch diameter corrugated metal pipe (CMP) which extends approximately 180 ft (horizontally) through the base of the embankment at a skewed section located near the east end of the dike (see Figure 3). Figure 4 (Section B-B) shows a section view of the outlet.

The design inlet invert elevation of the pipe at the bottom of the drainage tower is 677.85 ft; the design outlet invert elevation is 672 feet. The pipe was designed to be bedded on undisturbed soil beneath the dike and to have 1.5 percent grade from the inlet to elevation 676 ft, then 6.75 percent grade to the outlet end of the pipe. Design called for 3 concrete cutoff collars around the pipe with 2 located upstream of the dike centerline and 1 downstream of the dike centerline; the bottoms of the cutoff collars were to extend 6 inches into rock. There is a concrete paved ditch extending beyond (downstream of) the outlet end of the bottom discharge pipe to near the edge of the river.

The drainage tower by design is supported on a 6.5 x 8 x 1.5-ft thick reinforced concrete footing on rock. Removable precast concrete stoplogs which fit in guides on two open sides of the tower are used to control the inlet elevation of the drainage tower. The two open sides are each 4 ft wide. The stoplogs are lifted by means of a cable hoist and steel frame on top of the drainage tower. The design top elevation of the platform on top of the drainage tower is 705 feet.

Size and Hazard Classification - The Cliffside Units 1-4 old ash retention dike is a "small" size dam with "low" downstream hazard classification according to the criteria published in the Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams". This is derived from the relatively low height (<40 ft) of the dike and small potential storage capacity (<<1000 acre-ft) and the absence of downstream development within the small area of influence of any failure of the dike.

Historic Data

Design and Construction Information - Design studies and drawings were made for the Units 1-4 old ash basin in 1956 by Duke Power Company. Subsurface investigation was provided by Law-Barrow-Agee Laboratories (name changed to Law Engineering Testing Company in 1958). A total of 5 soil test borings was made in the dike foundation area, and 23 auger borings were made primarily to explore possible borrow sources located within the basin area and on nearby adjacent land on the southeast side of the basin. Three of the auger borings were made to check depth of refusal material along the line of the outlet pipe. Relatively undisturbed (Shelby tube) samples of foundation soils and bag samples of potential borrow soils were obtained for laboratory testing. Laboratory triaxial shear tests were performed on both foundation soils and compacted borrow soils, and classification and compaction tests were also performed. Law provided design consultation including analysis and evaluation of slope stability. The results of the investigation were presented in two reports (dated June 29 and August 21, 1956) prepared by Professor George F. Sowers. A third report (dated October 5, 1956) presented comments on final design plans as requested by Duke. Law job file number CH 224 contains the above information.

The 1956 subsurface investigation indicated that the site of the dike is underlain by alluvial (water deposited) sands and silts up to about 15 ft deep over residual soil or schist. The borrow soils were found to consist primarily of micaceous sandy silts/silty sands. Duke tentatively had planned dike slopes of 3H:1V for the upstream face and 2.5H:1V for the downstream face. However, the results of static slope stability analyses by Law indicated safety factors of about 2.5 and 2.0 for 2.5H:1V and 2H:1V slopes, respectively, for both faces of the dike; thus, the slope geometry was modified to the design configurations described previously under Physical Characteristics. A minimum compaction requirement of 95 percent of the (standard Proctor) maximum dry density was recommended. Further, it was suggested that a heavy rubber-tired roller would be more effective (than sheepsfoot) for compaction of the micaceous borrow soils. It was recommended that riprap protection be used in the downstream slope if the river could rise above the toe of the dike.

The soils report indicated that the foundation soil contained seams of sand which, if continuous, could lead to boiling below the dike due to water pressure from the reservoir. However, this potential condition was believed to be localized, and it was suggested that it would be more economical to correct the difficulty after it developed, rather than (provide design measures) to prevent it. It was noted that a sand filled trench at the toe of the dike could serve as a water pressure relief system. It was also noted that trouble with seepage pressures would disappear after the basin partially filled with ash.

The dike presumably was constructed in 1957. There is no readily available construction information such as quality control tests or inspection notes and memos. In spring of 1958, after the basin had been placed in service, water seepage from foundation soils below the downstream toe of the dike was observed. The areas of seepage were located approximately between stations 3+00 and 4+00, 6+50 and 8+50 and at Station 13+00 (see Figure 3). A system of pipes was installed to collect and concentrate the seepage for flow measurements. Initially (May, 1958), 13 points of flow measurement were established using 6-inch diameter corrugated metal pipes (and a 2-inch diameter galvanized pipe at one point, number 13). Seven additional pipes (6 to 10-inch diameter) were added later (July, 1958). Daily flow measurements were made and showed aggregate flows varying from about 50 to 60 gpm during the first month of monitoring. The flow points were examined for turbidity and several showed relatively continuous sandy or muddy flow during the first month; a number of other flows were sandy or muddy on occasion, primarily during and just after rainfall.

Professor Sowers was consulted (June, 1958) about the problem. He outlined (letter of June 2, 1958) ways of minimizing or controlling the seepage, but advised a program of "watchful waiting" and implementation of corrective measures only where necessary. He advised that areas of seepage that flow continuously sandy or increase in flow should be provided with a graded filter (inverted).

Duke continued to monitor the flows on a daily basis till November, 1958. During this time period the aggregate flow increased to a maximum of 93 gpm in August, but the dirty flows began to clear-up. After August, the aggregate flow gradually decreased and the flows generally were clear of soil particles. From November, 1958, to March, 1959, the flows were monitored once weekly; at the end of this time period the aggregate flow had decreased to approximately 30 gpm and all flows were running clear. During the remainder of 1959, only 6 selected flows (greater than 2 gpm) were monitored, on a weekly basis. In January, 1960, the 6 flows were monitored monthly, and the aggregate flow decreased from about 20 gpm to approximately 10 gpm by January, 1961, with all flows running clear. From February, 1961, to April, 1962, only point 13 (showing flow greater than 2 gpm) was monitored.

The monitoring program was terminated after an inspection was made in April, 1962. The inspection revealed that many of the outlets that showed "no-discharge" on the records had not actually dried-up; the seepage had diverted to new holes adjacent to the pipes, possibly due to disturbance of the pipes during high river flows. However, the seepage flows were observed to be running clear. It was noted that the outlets increased in flow after rains, but the flow was not muddy. It was also noted that the total flow appeared to be less than when measurements started. Because of the continual clarity of the seepage over the previous years, it was decided to discontinue making flow readings, but to continue making general observations.

In the April, 1962 inspection, the dike was noted to be in fair condition; it was observed that "grass was spotty and erosion was very evident both inside and out".

By 1973, the basin was nearing full capacity of settled ash. Some storage volume was restored by removing some 160,000 cubic yards of ash from the basin. The ash was hauled to a dry storage area (Auxiliary Ash Storage No. 1 located east of the Units 1-4 basin, near Suck Creek). In 1977, the basin was retired as an ash storage facility and converted to a yard drainage holding pond. (The Units 1-4 ash lines were rerouted to the Suck Creek ash basin.) Ash was removed to a depth of about 8 ft from an area about 220 ft wide by over 800 ft long within the western and southern portions of the basin, to create storage volume for the holding pond. The excavated ash was placed in the Unit 5 old ash basin. The ash in the remaining portions of the basin was covered with about 2 ft of topsoil and grassed. The general ash level in the basin prior to retirement was at about elevation 695 feet.

Duke file numbers C-280A, CS-224, CS-226A, CS-234B and CS-546B contain most of the information pertaining to the Units 1-4 old ash basin dike.

Instrumentation - Other than the seepage collection pipes and the seepage monitoring program discussed previously, there is no instrumentation on the Units 1-4 old ash retention dike.

Previous Inspections - No formal previous inspections of the Units 1-4 ash retention dike have been made by an independent consultant. However, Duke Power design engineers make formal inspections yearly, and more frequent observations are made by the plant engineers and personnel. The most significant past observation, available from the files, was the seepage problem discussed previously. Other conditions often noted in past inspections were surface erosion and tree growth on the dike.

Present Operation and Future Plans - As noted previously, the Units 1-4 ash basin was converted to a yard drainage holding pond in 1977. It still is being used for this purpose; sump and yard drainage from all 5 units at the plant is collected in the holding pond. From the holding pond the water is pumped to the Suck Creek ash basin.

The old drainage tower in the basin functions only as an emergency overflow structure for the holding pond. There is a shallow swale (constructed in ash) leading from the holding pond area of the basin to the drainage tower. The top stoplog in the drainage tower is at elevation 692 ft; the inlet end of the drainage swale is at elevation 693 ft, and the water level in the holding pond is maintained below this elevation. According to Duke design engineers, no overflows (through the swale and drainage tower) have occurred since retirement of the ash basin in 1977.

Future plans are to continue to use the basin as a holding pond. There are tentative plans to also use the basin for storage of spoil from periodic dredging of sand from in front of the nearby plant water intakes in the Broad River. Dredge spoil would be sluiced directly into the basin. Ash in a portion of the basin may be excavated and removed to two low areas in the Unit 5 ash basin, to create storage space for the dredge spoil.

Hydrologic Analysis

In general, the existing ground surface elevation in the retired Units 1-4 basin is approximately 697 ft, except in the yard drainage holding pond area where the water level is maintained below 693 ft, along the drainage swale between the holding pond and the drainage tower, and around the drainage tower where the surface is depressed down to the top stoplog elevation at 692 feet. The surface area of the basin at elevation 697 ft is about 12 acres, and at elevation 706 ft (top of dam) the surface area is approximately 14 acres. These areas are based on planimeter measurements on topographic maps available from the files (Duke Drawing Nos. C-2004, C-2005 and C-2006). Thus, there is an estimated 117 acre-ft of surcharge storage space available between elevations 697 and 706 feet.

The capability of the Units 1-4 basin to store runoff from a flood with a 100-year recurrence interval has been checked by approximate, conservative methods which assume 100 percent runoff and no outflow from the basin during the flood. The 100-year (24-hour duration) rainfall depth is 7.3 inches (from "Rainfall Frequency Atlas of the United States", TP-40, Weather Bureau, Reprinted 1963). The total area which drains into the basin is roughly estimated to be 65 acres, based on information from Duke's files and planimeter measurements on the USGS Cowpens SC-NC quadrangle sheet (1959). Thus, assuming 100 percent runoff, the total runoff volume is (7.3/12 x 65 =) 39.5 acre-ft; this is much less than the estimated available surcharge storage volume, 117 acre-ft, which discounts any storage volume that may be available below elevation 697 feet. Assuming no outflow and linear variation in surcharge storage from 0 acre-ft at elevation 697 ft to 117 acre-ft at elevation 706 ft, the stored runoff water level in the basin would reach approximately elevation 700 ft, leaving about 6 ft of calculated freeboard. If the basin level should be raised to elevation 700 ft with dredge spoil and/or yard drainage, a similar analysis would yield about 3 ft of calculated freeboard.

On the basis of the above approximate analysis, it is concluded that the existing Units 1-4 basin and ash retention dike should be hydrologically safe for a flood in excess of that produced by a 100-year storm.

Field Inspection Observations

The Units 1-4 old ash retention dike is almost completely overgrown with trees and vegetation. The crest is little more than a rutted trail (Plate 1). The upstream slope and basin area generally are covered with a dense, tall growth of lespedeza grass and weeds (Plate 2), except in the area of the yard drainage holding pond which was nearly empty at the time of inspection (Plate 3). Spoil material from dredging operations at the plant intakes was being pumped into the holding pond, on a temporary basis, at the time of inspection. Mimosa trees (visible in Plates 1, 2 and 3) grow on or overhang much of the dike crest. The downstream slope is heavily overgrown with trees and underbrush, though there is a couple of relatively clear areas (Plate 4). Much of the downstream slope was inaccessible to inspection due to the thick vegetation.

No slumps, slides or major active erosion were seen on the portions of the dike slopes that could be observed. Also, no seepage or wet areas were seen on the accessible portions of the downstream slope above the toe. The toe riprap was not seen, though some small rocks were observed at some locations next to the river.

Approximately 30 ft beyond the downstream toe of the dike there is a steep, 10 to 15 ft high bank which extends down to the edge of the river. A number of the old corrugated metal seepage collection pipes was observed at the toe of this bank. Most of the pipes were partially or completely unearthed, evidently as a result of scour during high river flows. Small seeps with no discernible flow were observed at several of the pipes (Plate 5). An area of slow flowing, yellow colored seepage was observed at the river's edge (Plate 6). This seep appears to be at or near the location of the old seepage monitoring point number 13. (The 2-inch galvanized pipe was not seen.) The seep did not appear to be carrying soil solids; the yellow color apparently is due to dissolution of a mineral in the soil. The bank next to the river is locally very steep, apparently due to river scour and backward sloughing.

The visible portion of the drainage tower (Plate 7) and the outlet end of the 30-inch diameter corrugated metal bottom discharge pipe (Plate 8) appear to be in fair condition. No seepage, drop-outs or erosion were seen in the embankment over the pipe. There was a small trickle of water flowing from the end of the pipe at the time of inspection.

Conclusions and Recommendations

No visual signs of deep seated instability or active internal erosion (piping) were observed on the Units 1-4 old ash retention dike, but inspection for evidence of these conditions was hampered by the thick growth of trees and underbrush on the downstream slope. Though the trees and underbrush hinder visual inspection, they appear to have provided a fair measure of protection of the dike against surface erosion. Since the dike essentially no longer serves as a water impoundment structure, the threat of seepage channels forming along tree root systems is no longer a concern for this dike. Thus, it is recommended that the trees and underbrush be left undisturbed.

No further study of structural stability of the old dike is recommended at this time. However, it is recommended that plant personnel continue to make periodic general inspections of the dike. These inspections should check in particular for the development of any significant erosion on the downstream slope and check for advancement of any backward sloughing of the steep riverbank toward the toe of the dike. Observations might also be made of the old seep areas next to the river, though the seeps presently are very small and may eventually disappear. A cleared trail maintained along the toe of the dike, and accessible from both ends of the dike and at a couple of intermediate locations, would facilitate these inspections.

The results of the hydrologic analysis indicate that the Units 1-4 basin should be capable of safely storing flood runoff produced by storms with a recurrence interval greater than 100 years. This degree of hydrologic safety for the "low" hazard dike is considered satisfactory by current regulatory guidelines, and no further study of hydrologic safety is recommended at this time.

The small trickle of water flowing from the end of the outlet pipe may be indicative of groundwater intrusion through the pipe joints or through a corroded hole in the pipe. Any plans to bring the old outlet works back into full service (e.g., as an overflow structure for a dredge spoil pond excavated near the drainage tower) should consider a thorough inspection of the pipe to check for deterioration.

CLIFFSIDE UNIT 5
OLD ASH BASIN DIKES

CLIFFSIDE UNIT 5 OLD ASH BASIN DIKES

Description

Physical Characteristics - The pertinent physical and geometric features of the Cliffside Unit 5 old ash basin dikes are shown on Figures 5 and 6. These figures and the following descriptions are based on copies of Duke's Drawings (prepared by Bechtel Corporation) C-3002 (date not discernible), C-3036 and C-3037 (both with latest revisions dated July 24, 1977), C-3038 (latest revision dated October 16, 1969) and C-3039 (latest revision dated June 5, 1970).

The Unit 5 old dikes are earthfill embankments, including a main dike, a saddle dike and an access road dike, arranged as illustrated in plan view on Figure 5. The main dike and saddle dike are the principal embankments which formed the ash basin. The dikes were designed to have a 20-ft wide crest at elevation 767 feet. The main dike is about 1460 ft long at the crest and has a maximum height of about 97 ft above the downstream toe; the saddle dike is approximately 590 ft long at the crest and has a maximum height of about 42 ft above the downstream toe (57 ft above the upstream toe). Design drawings called for 2.5H:1V upstream slopes, a 2.8H:1V downstream slope at the main dike and a 2.7H:1V downstream slope at the saddle dike.

Both the main dike and saddle dike were designed to have internal drainage consisting of a horizontal blanket drain connecting to a .5H:1V sloping chimney drain as illustrated by Section A-A (for the main dike) on Figure 6. The chimney and most of the horizontal blanket drain were designed to be 3 ft thick; they were to be constructed of graded sand. The design top elevation of the chimney drain was 692 feet. Design drawings also called for a cutoff trench "through all alluvial sand and gravel" beneath the upstream toe of the dike; the width of the cutoff was to equal the height of the dam and to be "backfilled with compacted borrow". The downstream toe of the main dike was designed to have an 18-inch thick blanket covering of riprap bedded on a 12-inch thick "transition" filter extending upslope to elevation 695 feet.

The outlet for the Unit 5 ash basin is a reinforced concrete drainage tower with bottom discharge into a 60-inch diameter reinforced concrete pipe (RCP) which extends approximately 500 ft (horizontally) through the left abutment of the main dike (see Figure 5). Figure 6 (Section B-B) shows a section view of the outlet.

The design inlet invert elevation of the pipe in the bottom of the drainage tower is 732 ft; the design invert elevation at the entrance of a dissipator box at the downstream end of the pipe is 678.75 feet. The pipe was designed to be bedded on a concrete cradle bearing in residual soil and to have about 5.3 percent grade down to a vent box some 410 ft (horizontally) downstream from the drainage tower; from the vent box to the entrance of the dissipator, 90 ft (horizontally) away, the pipe grade was to be about 35 percent. Design called for 3 concrete cutoff collars around the pipe beneath the upstream half of the dike section. A design revision called for complete encasement of the outlet pipe in reinforced concrete along a 95-ft long section beneath the central highest portion of the dike cross section.

The drainage tower by design is supported on a reinforced concrete footing bearing on residual soil. Removable precast stoplogs which fit in guides on 4 open sides of the tower were used to control the water level in the ash basin. The open sides are each 7 ft wide. The stoplogs are lifted by means of a cable hoist and steel frame on top of the drainage tower. The design top elevation of the platform on top of the drainage tower is 767 feet. The tower platform is accessed by a fixed timber walkway.

Size and Hazard Classification - The Cliffside Unit 5 old ash retention dikes (main dike and saddle dike) are "intermediate" size dams with "low" downstream hazard classification according to the Corps' criteria. This is derived from the moderate height (between 40 and 100 ft) of the dikes and the absence of downstream development.

Historic Data

Design and Construction Information - Design studies and drawings were made for the Unit 5 ash retention dikes in 1969 by Bechtel Corporation. Bechtel performed all engineering analyses of the dikes, including slope stability. Subsurface exploration, laboratory testing and evaluation of the engineering properties of foundation soils and proposed borrow soils were provided by Law Engineering Testing Company. Fifteen soil test borings and 7 test pits were made in the foundation area of the dikes, and several test borings were made on the western side of the ash basin to explore a potential borrow source. Relatively undisturbed samples of foundation soils and bag samples of potential borrow soils (from the west side of the basin and from excavation near the Unit 5 powerhouse) were obtained for laboratory testing. The laboratory testing included classification tests, compaction tests (modified Proctor), consolidation tests on foundation soils, triaxial shear tests on both foundation and compacted borrow soils (90 percent of modified Proctor) and relative density and permeability tests on proposed filter sands. This work was part of an overall subsurface investigation of the Unit 5 development reported under Law's job number CH 2003.

Beneath the downstream toe area of the main dike, the test borings and test pits indicated as much as 11 to 12 ft of alluvium underlain by residual micaceous silty sands/sandy silts in turn underlain by partially weathered rock and refusal material. Due to this thickness of alluvium at the toe and the close proximity of the Broad River, the dike was moved further upstream and the crest raised to maintain storage capacity. On the abutments of the main dike, the borings indicated a typical residual soil profile consisting of micaceous sandy clayey silts near the surface underlain by micaceous silty sands/sandy silts to depths of 12 to 13 ft where partially weathered rock was encountered. Refusal material was encountered at depths of about 22 to 36 ft in a couple of the borings and found to be biotite gneiss in one which was cored. One boring was made in the saddle dike area and indicated a residual soil foundation; the access road dike foundation had some alluvium in natural drainage draws. The borrow area borings encountered the typical residual soil profile like that found in the abutments.

Bechtel's stability analyses indicated a safety factor of 1.53 for the 2.8H:1V downstream slope of the main dike. Bechtel specifications called for minimum compaction of 90 percent of the modified Proctor maximum dry density for the dike fill construction.

The ash retention dikes were constructed in 1969/70 by Daniels Construction Company. There is no readily available information concerning construction of the dike.

In September of 1972, after the basin had been placed in service and the water level had reached approximately elevation 745 ft, inspections by both Duke and Bechtel engineers noted some problems of erosion and wet soil conditions on the downstream slopes of the main dike and saddle dike.

At the saddle dike two large areas of erosion (6 to 10 ft in diameter) were observed on the downstream slope approximately one-third the height of the dike down from the top, and erosion gullies were observed at the downstream embankment/abutment contacts. The lower one-third of the downstream slope of the saddle dike was "quite moist", and the exit end of the internal filter was not visible at the surface of the dike toe. There was silt accumulation at the toe. There was standing water in a drainage ditch located beyond the dike toe, around the Unit 5 cooling tower basin.

At the main dike the surface of the lower half of the downstream slope was observed to have a small gravel cover and numerous erosion gullies. The upper half of the slope was grassed. Erosion gullies were also observed at both the left and right downstream embankment/abutment contacts. Several small locations with clear water flowing at a slow rate from them were observed at the right abutment contact; these were not seen in later inspections, though "spots" of saturated soil were observed at the contact. The eastern portion (right side) of the downstream slope was more moist than other areas, and deterioration due to surface erosion progressed more rapidly there. Clear seepage (from internal drain) was observed flowing at about 4 different locations from the riprap covered toe of the main dike. The total flow was estimated to be about 8 to 10 gpm in September, 1972; in May, 1973, it was estimated to be 15 to 20 gpm and thought to come primarily from the western side of the dike. During a September, 1972 inspection, the Bechtel representative noted a 10-ft diameter gunited basin at the toe in the center of the main dike. The basin was full of saturated sand and had a small trickle of water flowing from it. The function or purpose of this basin was not known.

Correspondence in Duke's files suggests that the erosion problems were repaired sometime in 1973. Correspondence in 1977 indicated a problem of leakage beneath the saddle dike. (Water was seeping primarily from the base of the right abutment of the dike and draining into the ditch around the Unit 5 cooling tower basin. The ditch stayed practically full with the seepage water.) It was decided not to make permanent repairs to control the seepage, since the basin was nearing retirement, but to visually monitor the seepage on a daily basis to check for changed conditions such as flow rate, turbidity and location.

The basin was almost completely filled to capacity with settled ash by 1979. In 1980, the basin was retired and the exposed ash surface was graded for drainage, then covered with soil and grassed, except in two low upstream reaches of the basin where some water was ponded. These two low areas still exist and one (easternmost) still has ponded water, apparently being springfed; the other has dried-up.

Duke file numbers C-280A and C-5434 contain much of the information pertaining to the Unit 5 old ash basin dikes.

Instrumentation - There is no instrumentation on the Unit 5 old ash retention dikes.

Previous Inspections - Bechtel and Duke engineers and plant personnel made previous inspections of the Unit 5 ash retention dikes. The most significant past observations, available from the files, were the 1972 erosion and seepage problems noted previously.

Present Operation and Future Plans - The Unit 5 ash basin has been retired. Surface runoff is directed through the drainage tower. The drainage tower has been lined with a vertical pipe which reduces the discharge capacity of the overflow structure. (The reason for the pipe lining is not readily apparent from the files; it perhaps was an effort to seal leakage of wet ash through some open joints between stoplogs in the tower.) The two low areas of the basin may eventually be filled-in (perhaps with ash hauled from the Units 1-4 basin) and grassed.

Hydrologic Analysis

The Unit 5 basin no longer serves as a water impoundment, but could pond surface runoff at times of heavy rainfall. The capability of the basin to store runoff from the 100-year storm has been checked using an approximate analysis, similar to that outlined previously for the Units 1-4 basin. This analysis assumes no outflow from the basin during the storm. However, the runoff amount is determined from published correlation between rainfall and runoff (Figure 10.1, SCS NEH-4, 1972) using an estimated curve number (CN) of 71 which yields 4 inches of direct runoff from the 7.3-inch, 100-year (24-hour duration) precipitation amount. The CN value is based on hydrologic Class B soils (primarily Madison gravelly loam) in the drainage area outside the basin and assumed hydrologic Class C soils within the basin area; it also assumes a pasture or range type cover (over the entire drainage area), fair hydrologic condition and antecedent moisture condition II (AMC-II). The total area which drains into the basin is estimated to be approximately 200 acres, based on the USGS topographic map. Thus, the total runoff volume is estimated to be approximately (4/12 x 200 =) 67 acre-feet.

Prior to retirement of the Unit 5 basin the ash level generally reached approximately elevation 762 ft (or 5 ft below the crest) except in the two low areas described previously. However, while the ash lines were being rerouted to the Suck Creek basin just prior to retirement, the basin was filling quickly with ash. In an effort to prolong the storage life, the ash was mounded-up in the central portion of the basin. During a May 10, 1979 inspection by Duke design engineers, the large ash mound appeared to be higher than the original low point on the (saddle) dike. (The low point had been raised with fill prior to ash buildup.) After sluicing operations were diverted to the Suck Creek basin, the mound was to be leveled and graded to a depth of approximately one foot over 25 percent of the basin area.

The area of the ash basin is approximately 37 acres at elevation 762 ft, based on the USGS topographic map and information from Duke's files. The existing ground surface elevation in the basin is not precisely known. However, a rough estimate of the surcharge volume available in the basin is made assuming elevation 763 ft over 75 percent of the basin area and 764 ft over 25 percent of the basin. These elevations should conservatively account for the graded ash mound and soil cover that was placed upon retirement of the basin. Ignoring the low areas and "bank" storage, the calculated available surcharge storage is approximately 139 acre-ft or more than twice the estimated total runoff volume (67 acre-ft) from the 100-year storm. Assuming no outflow and linear variation in surcharge storage from 0 acre-ft at elevation 763 ft to about 28 acre-ft at elevation 764 ft, then 138 acre-ft at elevation 767 ft, the stored runoff water level in the basin would rise to approximately elevation 765 ft, leaving about 2 ft of calculated freeboard.

On the basis of the above approximate analysis, the retired Unit 5 ash basin should be capable of safely storing storm runoff from the 100-year event.

Field Inspection Observations

The crest of the Unit 5 ash retention dikes is in good visual condition and has a surfacing of what appeared to be black cinders. The downstream slope of the main dike had been mowed just prior to inspection and was in very good visual condition (Plate 9). The downstream slopes of the saddle dike and access road dike similarly were in good visual condition with recently mowed grass cover. Only the uppermost 3 to 5 ft or so of the upstream slopes were visible since the basin was filled to capacity with soil covered, settled ash. The basin area and upstream slopes were clear and free of woody vegetation (Plate 10).

No slumps, slides or major erosion were seen on the dike slopes, and no seepage or unusually wet areas were observed on the downstream slope above the toe.

The riprapped toe of the main dike and area downstream of the toe were covered with bushes and trees. Clear seepage was flowing from the toe at a number of locations. Several of these combine to form a larger flow (Plate 11) that runs into a natural drainage channel below the toe. The toe area below the right aubtment is swampy and has wet ground vegetation due to poor drainage.

A thin cracked layer of concrete (or gunite) was observed in one area on the downstream toe of the main dike; this apparently is the gunite basin (of unknown purpose) referred to in the Bechtel engineer's inspection in 1972.

Gradual seepage from natural ground below the downstream right abutment of the saddle dike was also observed. The seepage drains into and stands in the drainage ditch (Plate 12) around the Unit 5 Cooling Tower B, promoting growth of wet ground vegetation. The seepage emerges from a bank next to the ditch (near the automobile shown in Plate 12). The seepage is red colored and evidently mineral rich; a red brown crusty deposit has formed at the seepage outcrop. Mr. Roberts indicated the seepage problem here used to be much worse with water bubbling from the ground and the ditch completely filled with water.

The visible portion of the drainage tower (see Plate 10) and the dissipator box at the downstream end of the 60-inch diameter RCP outlet appeared to be in good condition. No seepage, dropouts or erosion were seen in the embankment over the pipe.

Conclusions and Recommendations

The Unit 5 ash retention dikes are in good visual condition, and no further study of structural stability is recommended. No remedial action appears necessary, other than routine maintenance and inspections by plant personnel. The seepage from the toe of the main dike and that from the base of the right abutment of the saddle dike should be observed for changed conditions during the routine inspections.

The results of the hydrologic analysis indicate that the Unit 5 basin should be capable of safely storing flood runoff from the 100-year storm. This degree of hydrologic safety for the "low" hazard dikes is considered satisfactory by current regulatory guidelines, and no further study of hydrologic safety is recommended at this time. Though the hydrologic analysis assumed no outflow during the storm, the outlet works should be maintained in good working order to allow drainage of impounded storm runoff.

If there are no plans to utilize the basin for water impoundment in the future (other than temporary retention of storm runoff), natural vegetation could be allowed to grow on the dike slopes.

CLIFFSIDE UNITS 1-5

SUCK CREEK NEW ASH BASIN DIKES

CLIFFSIDE UNITS 1-5 SUCK CREEK NEW ASH BASIN DIKES

Description

Physical Characteristics - The pertinent physical and geometric features of the Cliffside Units 1-5 Suck Creek new ash basin dikes are shown on Figures 7 and 8. These figures and the following descriptions are based on prints of Duke's Drawing Nos. C-2015 (latest revision dated April 17, 1981), C-2015A and C-20015B (both with latest revisions dated January 31, 1981).

The Suck Creek ash basin was formed by construction of two earthfill dikes across Suck Creek, bracketing a 5600-ft long meandering reach of the natural stream valley for ash storage. At the upstream dike, the creek was diverted through a canal to the Broad River. The arrangement of the dikes and canal are shown on Figure 7.

The downstream dike, located just upstream of the original confluence of Suck Creek with the Broad River, is 876 ft long. The upstream dike is 890 ft long. Both dikes were designed to have 15-ft wide crests at elevation 775 feet. Maximum height of the downstream dike is about 120 ft above the downstream toe; that of the upstream dike is about 60 ft above the downstream (outside) toe and 65 ft above the inside toe.

The downstream dike was designed to have a final upstream slope of 2.5H:1V from the crest down to a 15-ft wide berm at elevation 737 ft, 2H:1V slope below this berm to a lower, 50-ft wide berm at 675 ft; then 2H:1V slope down to prepared foundation grade. The final downstream slope was designed to be 2.5H:1V with 2 berms: one 15-ft wide at elevation 725 ft and another 20 ft wide at 680 feet. The 2.5H:1V slope below the lower berm has a cover of riprap designed to be 2.5 ft thick and bedded on a 1-ft thick crushed stone layer. Beyond the downstream toe there is a channel leading to the river. The banks of this channel are protected with weathered riprap.

The upstream dike was designed to have a 2.5H:1V inside slope and 2.5H:1V outside slope down to a berm at elevation 730 feet; then 2H:1V slope below the berm. The outside slope (and berm) below elevation 735 ft were designed to have a weathered riprap cover.

Both the downstream and upstream dikes were designed to have internal drainage consisting of a zoned toe drain and blanket drain extending to a zoned trench drain located beneath the dike at approximately one-third the total base width of the dike upstream from the toe (see Sections B-B and C-C on Figure 8). Design called for the zoned drains to consist of a 1-ft thick coarse filter sandwiched between 9-inch thick fine filter layers. Both dikes have rock intercept ditches located along the upstream and downstream embankment/abutment contacts.

The outlet for the ash basin is a reinforced concrete drainage tower with bottom discharge into a 42-inch diameter RCP which extends approximately 700 ft (horizontally) beneath the downstream dike at its left abutment (see Figure 7). Figure 8 (Section A-A) shows a section view of the outlet.

The design invert elevation of the pipe in the bottom of the drainage tower is 708.75 ft; the design outlet invert elevation is 660 feet. The pipe was designed to be bedded on fill concrete and to be laid at 5 different grades as illustrated on Section A-A, Figure 8. At each grade change the design called for an anchor block. The design also called for 3 reinforced concrete cutoff collars around the pipe beneath the central and upstream portion of the embankment cross section. The portion of the pipe beneath the downstream one-third of the embankment was designed to be encased in a zoned drain similar in design to the internal drainage blanket and connected to it. (The coarse filter zone, next to the pipe, was designed to be 6 ft thick.)

The drainage tower by design is supported on a reinforced concrete footing anchored to rock. Removable precast stoplogs which fit in guides on 2 open sides of the tower are used to control the water level in the ash basin. The open sides are each 5 ft wide. The stoplogs are lifted by means of a removable cable hoist and steel frame on top of the drainage tower. The two closed sides of the tower have 5-ft wide permanent openings beginning at elevation 770 feet. The design top elevation of the platform on top of the drainage tower is 774.5 feet. The tower platform is accessed by a fixed walkway constructed of timber poles, steel framing and wood planking; by design the poles are encased in concrete footings which are anchored to rock. The drainage tower is encompassed by a floating skimmer with plywood "skirts" to help prevent floating debris and surface scum from entering the overflow structure.

Size and Hazard Classification - The Suck Creek facility has a "large" size classification and "low" downstream hazard potential according to the Corps' criteria. The large size is based on the relatively great height (greater than 100 ft) of the downstream dike; the low downstream hazard potential is due to the absence of downstream development.

Historic Data

Design and Construction Information - Design studies, drawings and specifications were made for the Suck Creek ash basin in 1972/73 by Duke Power Company's Design group. Borings for the dike foundations and borrow areas and laboratory testing of borrow soils were performed by Dukes's Construction group in the spring and summer of 1973. Law Engineering Testing Company provided some geotechnical consultation during design and at times during construction when requested by Duke Power. Law's reports, notes and other information pertaining to the Suck Creek project are included in job file number CH 2003.

The subsurface exploratory work revealed a thin residual soil profile overlying jointed saprolite and partially weathered rock at the site of the downstream dike. All the test borings for this dike encountered refusal to the soil drilling tools at depths generally between 5 and 10 feet. Core drilling of refusal material revealed an extensive zone of severely weathered and fractured gneiss rock with numerous zones of pegmatite. The weathered and fractured rock zone was found to be thickest on the abutments (15 to 30 ft) and thinnest immediately beneath the valley bottom where the creek was observed to run on exposed rock. Ledge rock outcrops were observed on the eastern (right) abutment, and a local slump (landslide) mass or alluvial deposit of gravelly soil was found on the eastern abutment, just downstream of the rock outcrops and near the creek.

Because of suspected moderate permeability of the weathered, fractured rock zone and thin soil overburden, much of which would be removed down to the fractured rock during foundation preparation, a generous internal drainage system under the downstream slope was recommended by Law Engineering and incorporated in design (see Physical Characteristics). The purpose of the drainage system was to intercept seepage through the jointed saprolite and fractured rock foundation and relieve uplift pressures on the embankment and also avoid saturation of the downstream toe.

Reconnaissance in 1973 discovered several rock outcrops along the creek valley slopes in the vicinity of the proposed borrow sources located within the basin area, indicating the possibility of shallow rock in the borrow area. Law suggested that a number of boring locations be explored at resonably close spacing to evaluate the average depth to rock or weathered rock too hard to excavate economically for borrow material. Also, it appeared that the borrow would contain numerous gravel and cobble to boulder-sized pieces of weathered to unweathered rock. Law recommended that the embankment fill specifications allow only pieces of rock smaller than 8 inches in the fill. Additional exploration by test pits and auger borings were done in 1974 to investigate the availability and character of borrow soils for the embankment construction; the work was done by Duke personnel and equipment under Law Engineering's technical direction. The borrow soils were predominately silty sands and gravelly silty sands.

Slope stability analyses of the dikes and hydrologic analyses of the basin were performed by Duke Power design engineers. The slope design criteria used by Duke required a minimum safety factor of 1.25 at "end of construction" and 1.50 under "steady state" operating conditions. Actual computed safety factors were slightly greater than these minimum criteria. Effective embankment soil shear strength parameter used in the analysis of the downstream dike were $O' = 33^{\circ}$ and $C' = 700$ psf for the maximum height section (crest elevation 775 ft) of the dike. The analysis assumed a full (maximum) reservoir level of 772 ft and a total unit weight of 132 pcf for the embankment soils. Hydrologic analyses required the basin to safely pass runoff from a 100 year (24-hour duration) storm with a maximum water elevation less than or equal to 772 feet.

The Suck Creek basin was constructed in two phases. The first phase consisted basically of excavation of the diversion canal and construction of the upstream dike to elevation 745 ft and the downstream dike to elevation 725 feet. The first phase construction was begun in 1974 and completed in 1975 by Burns and Spangler Construction Company. The second phase construction consisted primarily of raising both dikes to elevation 775 feet. However, the downstream dike was raised in two stages, with the first stage involving construction of the dike to a temporary elevation of 737 ft sometime in late 1979. The second stage construction was done by R. L. Wallace Construction Company and was essentially completed in late 1980.

Specifications called for the dike embankments (Group I fill) to be compacted to minimum densities of 95 percent of the standard Proctor maximum dry density. Placement soil moisture contents were specified to be within ± 3 percent of the optimum moisture content. Sound, unweathered rock was specified for riprap on the toe of the downstream dike. More weathered "dirty" riprap was permitted on the channel below the downstream dike and on the toe of the upstream dike.

During Phase I construction in May, 1975, the middle section of the partially filled upstream dike washed out when flood water overtopped and breached a temporary cofferdam that was used for diversion of Suck Creek. Runoff from heavy rainfall (estimated at approximately 5 inches in a 12 hour period), backed up in the diversion canal due to a construction access fill bridge that had been placed across the canal. The fill bridge was about the same height as the cofferdam and had a small pipe culvert which was not sufficient to carry the flood flow; as a result the water backed up and overtopped the cofferdam.

Prior to Phase II construction at the downstream dike, test borings were made from the crest (at elevation 725 ft) of the Phase I embankment which had been in-place about 3 years. Law Engineering made these borings and also performed field permeability tests. Borings through the embankment over the right abutment found an apparent phreatic surface considerably depressed compared to that encountered in the other borings. Zones of very soft embankment soil were encountered near the embankment bottom in these borings; loss of drilling fluid occurred at the top and within the soft zones. Blue dye was introduced into the holes on the right abutment length of embankment, but the dye never showed up at the downstream toe or in the internal drainage outlet. (Mr. P. C. Gurley of Duke Power's Design Division has indicated the dye eventually was observed several months later below the right abutment.) Also, soft zones of fill were found within the embankment well above the indicated bottom in borings on the right abutment, and concentrations of rock pieces were encountered in the fill in some of these borings.

The depressed water levels in the right abutment borings were thought to possibly be caused by opened joints in rock in the right abutment. It was surmized that the very soft embankment soils may have formed due to the erosion of soil fines into open rock joints. An alternative explanation was the very soft fill at the bottom of the embankment may have been the result of an uneven prepared abutment surface which prevented adequate compaction of the soils using large mechanized equipment, and the very soft zones within the embankment might have been material that was uncompacted due to rock pieces being included in the fill. It appeared, based on the dye tests, that seepage entering the foundation was not being intercepted by the drain; but was either going beneath the blanket and toe drain, or going beneath and around it in the abutment hillside.

As a result of the above, Law Engineering advised that the blanket drain for Phase II construction should be placed directly on the stripped, prepared foundation, with no intermediate layer of compacted fill, to increase the effectiveness of the drain in intercepting underseepage; this was incorporated in design. To reduce the possibility of internal erosion of soil into open joints in weathered rock, two alternatives were recommended. The first was to strip the weathered rock of its thin soil overburden (where overburden less than about 10 ft thick) within at least the middle one-third (core area) of the Phase II dike cross section; clean and thoroughly slush grout the exposed surface of the rock to seal open joints; then backfill with the more clayey borrow soils in the first 5 ft above the slush grouted rock foundation. The second alternative was to extend the blanket drain to the centerline of the Phase II embankment and place a formal grout curtain cutoff through the badly weathered and jointed rock zone along the centerline of the dike. Essentially, the first alternative (stripping and slush grouting) was done. Also recommended, and implemented, was removal of rock overhangs and sloping back (.5H:1V) of near vertical rock ledges within the middle one-third of the embankment at the abutments, to reduce differential settlement and aid in obtaining a tight contact between the embankment and abutment.

During Phase II construction at the downstream dike, a temporary lateral drain was installed to route seepage from the drainage blanket of the Phase I dike through the Phase II dike foundation preparation area. The drain consisted of a trunk drain running along the lowest portion of the prepared foundation, approximately perpendicular to the centerline of the dike, and several branch drains connecting various springs and low points to the trunk drain. The drains were constructed of coarse filter material on the rock foundation and fine filter material over the coarse filter. The Phase II fill was constructed over these drains, but before completion of the Phase II embankment, a grouting operation was undertaken to seal the temporary drains. This was accomplished by drilling and grouting through holes on the embankment when the embankment was no higher than about 20 ft above the drains. The grout was specified to be a combination of sodium silicate, portland cement and other chemical components.

Duke file numbers C-280A and C-5434 contain much of the information pertaining to the Suck Creek basin and dikes.

Instrumentation - There apparently is no instrumentation on the existing upstream and downstream dikes. Early design drawings indicate several surface monuments for settlement monitoring on the downstream slope just below the Phase II crest (elevation 775 ft) of the downstream dike and two surface monuments near the Phase I crest (elevation 725 ft). Later, revised drawings do not show the monuments near the Phase II crest. Those on the Phase I crest, if installed, were presumably covered by Phase II construction.

Previous Inspections - No formal previous safety inspections of the Suck Creek ash retenton dikes have been made by an independent consultant. However, Duke Power engineers inspected the various phases of construction and perform formal inspections yearly; more frequent general observations are made by the plant maintenance personnel. No significant problems at the dikes have been noted in the relatively brief time period since completion of the Phase II construction.

Present Operation and Future Plans - Sluice pipe lines discharge ash slurry from all five units at the steam plant into the upper end of the Suck Creek ash basin. Also, water from the yard drainage holding pond at the Units 1-4 basin is pumped into the Suck Creek basin. Water circulates through the basin and leaves through the drainage tower at the downstream dike.

The water level in the basin was at about elevation 738 or 739 ft at the time of inspection. The water level will gradually rise, as the basin fills with settled ash, to the maximum operating stoplog elevation of 770 feet. Afterward, the water level will remain relatively constant at or just above the maximum stoplog elevation, except during chemical cleaning of the plant boilers. During and after chemical cleaning, the plant effluents are retained in the basin for a period of 6 days for pH adjustment before making a release into the river. When the basin water level approaches the maximum operating level, the operation will involve lowering the water level, just prior to chemical cleaning, to allow sufficient storage volume for the 6-day accumulation of boiler rinse, ash sluice, yard drainage and sump water, and 100 percent runoff from a 10-year, 6 day duration rainfall (9.75 inches).

Future plans are to operate as described above. Duke's current projections are that the present Suck Creek ash basin should have sufficient storage capacity to last until the year 2001. Thus, no major additions or modifications to the ash storage basin are presently being contemplated for the near future.

Hydrologic Analysis - An independent hydrologic analysis of the Suck Creek ash storage basin has been made based on the readily available information. Elevations and geometrical data shown on the design drawings have been used in the analysis but have not been verified by actual measurements with surveying instruments. The pertinent hydrologic data used in the analysis are summarized below:

Drainage Area:	258± Acres
Average Land Slope:	13 percent
Estimated Curve Number (CN):	80
Hydraulic Length:	2500 ft
Time of Concentration:	0.3 Hr.
Top of Spillway Elevation:	770 (Max. Stoplog Height) ft
Top of Dam Elevation:	775 ft
Pond Area at Top of Spillway Elevation:	91± Acres
Pond Area at Top of Dam Elevation:	97± Acres
Surcharge Storage:	
El. 770-772:	189± Acre-Ft.
El. 772-775:	281± Acre-Ft.
Maximum Base Flow:	8 cfs (From Ash Sluice Lines)

The above drainage area is from Duke's files and closely agrees with planimeter measurement on USGS topographic maps. The pond area (and calculated storage volumes) are based on planimeter measurements on a topographic map available from the files (Duke Drawing No. C-2015). The curve number (CN) was estimated assuming approximately 35 percent of the drainage area covered with water and the remaining area pasture or range with Class B soils, fair hydrologic condition and AMC-II.

Based on the large size of the downstream dam (but low hazard potential), the Corps of Engineers' criteria stipulate a design storm equivalent to at least 1/2 the probable maximum precipitation (1/2 PMP). From Hydrometerological Report 33 (with adjustments by the NWS in 1975) the 6-hour, 10-square mile rainfall depth is 29.2 inches for the Cliffside area. Adjusting for storm duration, the 24-hour rainfall amount is 36.5 inches (by Fig. 2-6 in SCS TR-60, 1976). Thus, 1/2 PMP equals 18.25 inches. Based on the estimated CN value of 80, the amount of direct runoff is 15.7 inches, or a volume of (15.7/12 x 258 =) 337.5 acre-feet. The total present storage volume available between the maximum spillway elevation (770 ft) and top of dam elevation (775 ft) is approximately 470 acre-feet. Thus, the Suck Creek basin presently could store the runoff from 1/2 PMP with about 1.4 ft of freeboard, conservatively assuming no outflow during the storm and a basin water level at 770 ft at beginning of the storm.

When the basin approaches retirement, it is possible that the ash level could be higher than the maximum spillway elevation, particularly at the upper end of the basin where the ash is sluiced into the basin. (Design drawings indicate a maximum ash elevation of 772 feet.) This of course would reduce the surcharge storage volume available for containment of flood runoff. Thus, the capability of the basin to pass runoff from the 1/2 PMP storm at retirement was checked assuming the ash level at elevation 772 ft in the basin except right around the discharge tower (essentially no surcharge storage between elevations 770 and 772 feet). A discharge curve was developed for the drainage tower, and inflow hydrographs for the 1/2 PMP storm (both 6-hour and 24-hour durations) were prepared using procedures and aids contained in the Soil Conservation Service's National Engineering Handbook, Section 4 (SCS NEH-4, 1972). Routing curves were developed, and the inflow hydrographs were routed through the basin using graphical procedures. The peak basin water elevation produced by this flood routing was slightly less than 774 ft, leaving at least 1 ft of calculated freeboard. Using another routing curve which assumed surcharge storage volume between elevation 770 and 772 ft equal to one-half its present volume (i.e., simulating a final ash deposit above 770 ft that occupies only 1/2 the volume between 700 and 772 ft), a peak basin water level slightly greater than 773 ft resulted, leaving almost 2 ft of calculated freeboard.

The above analysis indicates that the Suck Creek basin should be capable of passing flood runoff from the 1/2 PMP storm, though the margin of freeboard may be small when the basin approaches full capacity with settled ash.

Field Inspection Observations

Downstream Dike - The crest of the downstream dike has a surfacing of crushed stone which had been partially overgrown with grass (Plate 13). No tension cracks or major depressions were seen on the crest.

The water level in the ash basin was just above the level of the uppermost berm on the upstream slope of the dike, or at about elevation 738 or 739 ft at the time of inspection. The upstream slope above the water surface was covered with a relatively tall stand of mature rye grass (Plate 14). Remnants of a biodegradeable fabric used for temporary erosion control during establishment of the grassing were visible on the slope. No slumps, slides or erosion were observed on this slope.

The downstream slope similarly was covered with the rye grass, except on the riprapped portion of the slope below the lowermost berm (Plate 15). Remnants of the erosion control fabric were also seen on this slope. No slumps, slides, or seepage were seen on the downstream slope. Narrow erosion gullies were observed on the portion of the downstream slope above the uppermost berm. The worst of these is about 3 ft deep (Plate 16). The gullies appeared to predominantly occur along rips or tears in the erosion control fabric. The fabric appeared to have creases at regular intervals running up and down the slope; the rips in the fabric (and the gullies) seemed to occur primarily along the creases. There is an accumulation of silt on the uppermost berm (Plate 17), evidently the result of erosion of soil from the slope above the berm. There was evidence of poor drainage and ponding of surface runoff on this berm (see Plate 17). The slope between the upper and lower berms on the downstream face was free of the gully erosion (Plate 18). No seepage was observed at the interface of the embankment with the rock ledge (visible in Plate 18) near the base of the right abutment.

The riprapped channel leading from the downstream toe of the dike to the river was clear and relatively free of vegetation (Plate 19). The river level was observed to be below the channel bottom elevation, and thus was apparently far below the normal elevation 660 ft which is above the channel bottom according to the design Section B-B on Figure 8. (A check of river stage by Duke confirmed that the river level was below elevation 660 ft at the time of inspection.) There was a relatively small flow of clear seepage from the base of the riprap at the toe of the dike (Plate 20). A couple of small clear seepage flows were observed beyond the dike toe at the left (west) bank of the riprapped channel, near the end of the channel. Several very small, red colored seeps (like that shown in Plate 21) were also seen along the left bank of the channel.

Upstream Dike - The upstream dike was observed to have conditions similar to those of the downstream dike. The crest has a surfacing of crushed stone (Plate 22). No tension cracks or major depressions were seen on the crest.

The inside slope (Plate 23) and outside slope (Plate 24) were covered with rye grass. Practically all the erosion control fabric had degraded and only a few traces remained. No significant erosion was seen on the slopes, and there was no evidence of either shallow or deep shear failures. No seeps or wet soils were observed on the downstream slope.

The riprap on the outside toe of this dike (Plate 25) is of poorer quality than that at the downstream dike; the rocks are more weathered. Small bushes are beginning to grow in the riprap. The low area beyond the toe (out to the diversion channel of Suck Creek) is covered with a tall stand of lespedeza grass. Though this vegetation obscured the area beyond the toe, there did not appear to be any seepage or wet areas at the base of the riprap. (The impounded water level on the inside slope was only 8 or 9 ft higher than the level of the outside slope berm at the time of inspection.)

The outside toe portion of the upstream dike appeared somewhat different than called for by the design illustrated on Section C-C of Figure 8. The riprap does not extend upslope (5 ft vertically) from the berm. Also, the outlet end of the internal drain is shown to be just above the berm on the design section. However, it is understood from Duke Design that, as-built, the internal drainage blanket is located beneath the berm and has its outlet end covered with the riprap on the slope below the berm.

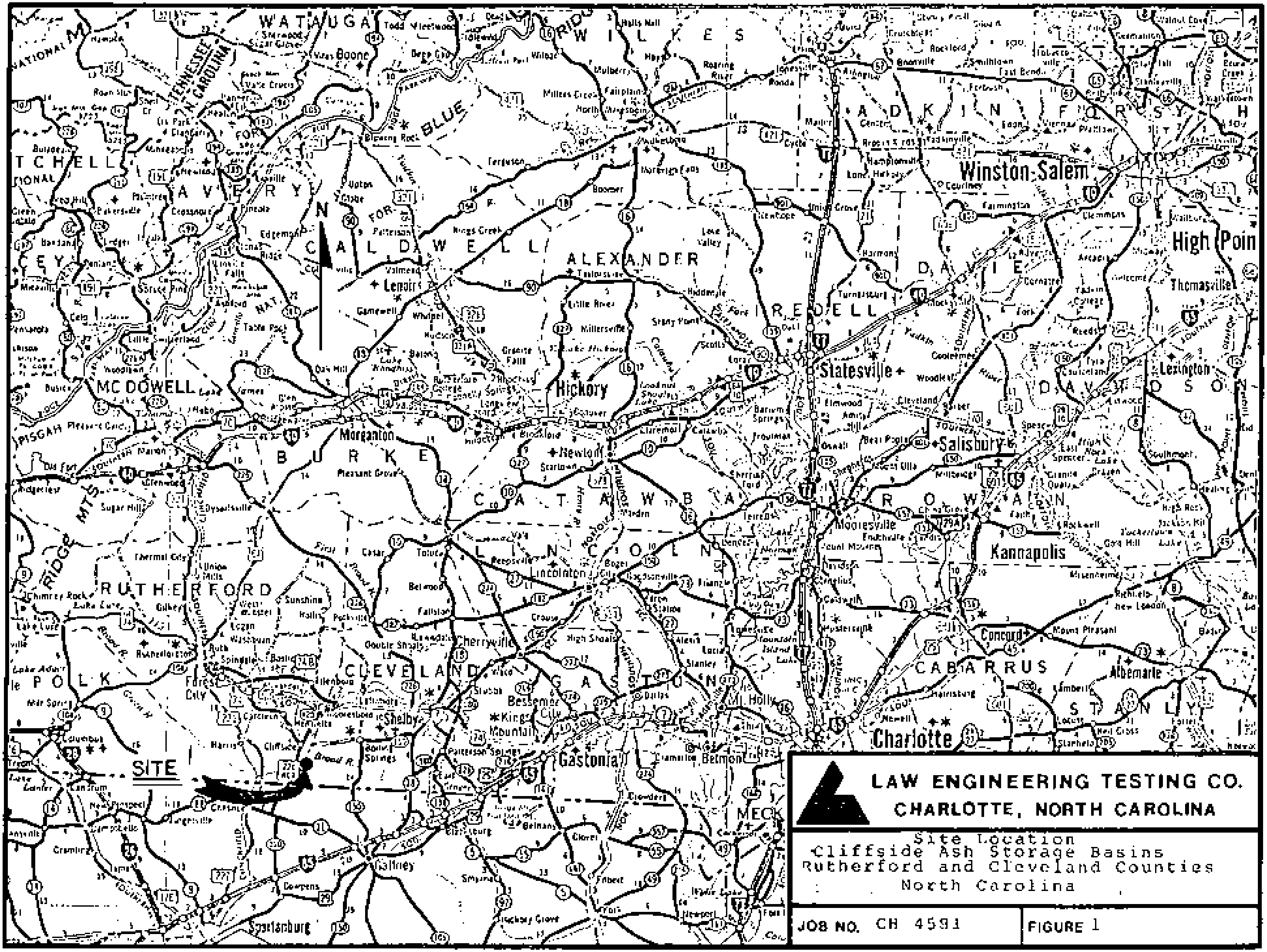
Outlet Works - The visible portion of the drainage tower was in good visual condition (Plate 26). Water was flowing into the drainage tower at the time of inspection and discharging from the outlet end of the 42-inch diameter bottom discharge pipe (Plate 27) which also was in good visual condition. Some surface erosion was observed in the soil fill just back of the headwall at the outlet. However, no seepage was seen around the pipe outlet and no dropouts were observed in the embankment soils over the pipe.

Conclusions and Recommendations

The Suck Creek ash retention dikes are in good visual condition, and no further study of structural stability is recommended at this time. No visual signs of deep seated instability or internal erosion (piping) were observed. Actual measurements of geometric features, such as slope angles, crest widths and elevations, etc., were not made, but most external physical characteristics appeared to be substantially those called for by design, on the basis of visual observation. An exception is the apparently lower than design elevation of riprap on the outside toe of the upstream dike. Also, the as-built location of the internal blanket drain of the upstream dike reportedly is different than indicated on the design section. It is recommended that Duke design engineers make note of these as-built features on the project drawings.

It is recommended that repairs be made to the gully erosion noted on the downstream slope of the downstream dike. No other remedial action appears necessary on the dikes, other than routine maintenance and inspections by plant personnel. It is recommended that Duke design engineers inspect the dikes from time to time as the operating level of the water in the basin rises. It is suggested that these inspections be done for every 5 to 10-ft rise in the water level, but not less than once yearly. The inspections should check in particular for development of saturation of the downstream slope soils of both dikes, seepage at the embankment interface with the rock ledge at the left abutment of the downstream dike and changes in the clarity or flow of the seepage from the downstream dike toe.

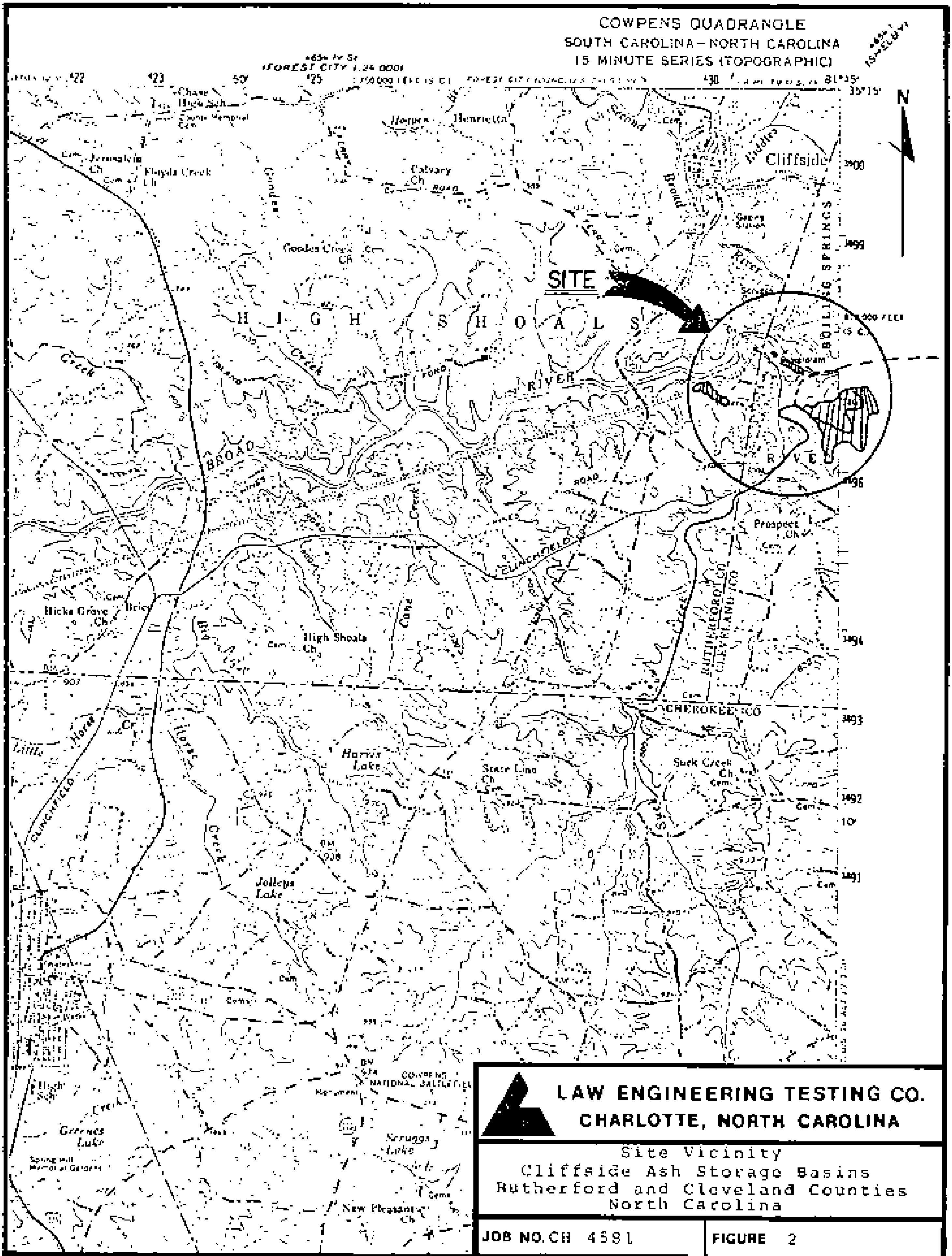
The results of the hydrologic analysis indicate that the Suck Creek ash basin should be hydrologically safe for a flood produced by 1/2 PMP. This degree of hydrologic safety for the "low" hazard dike is considered satisfactory by current regulatory guidelines, and no further hydrologic study is recommended at this time. The outlet works for the Suck Creek basin appeared to be in good working order at the time of inspection. It would be advisable to repair the soil erosion occurring back of the headwall at the outlet end of the discharge pipe, to minimize the possibility of the erosion deepening, progressing down the bank, and undermining the chute below the outlet.



LAW ENGINEERING TESTING CO. CHARLOTTE, NORTH CAROLINA	
Site Location Cliffside Ash Storage Basins Rutherford and Cleveland Counties North Carolina	
JOB NO. CH 4591	FIGURE 1

Ref: Official North Carolina Road Map for 1976-1977

Scale: 1" = 13 Mile (Approx.)



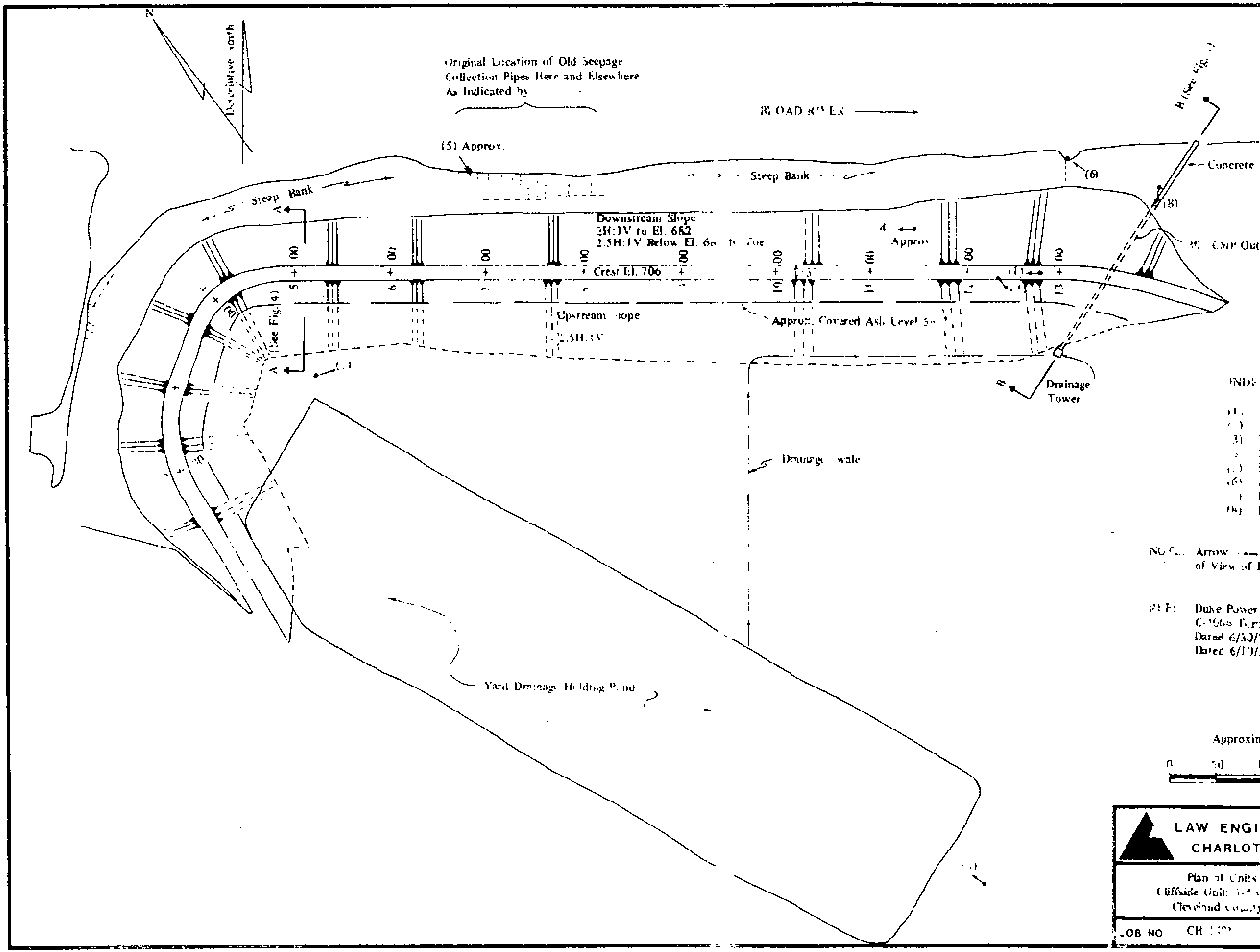
LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Site Vicinity
Cliffside Ash Storage Basins
Rutherford and Cleveland Counties
North Carolina

JOB NO. CH 4581	FIGURE 2

Ref: USGS Cowpens, S. C.-N.C. Quadrangle (1959)

Scale: 1" = .99 Mile (approx.)



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- Plate 4
- Plate 5
- (6) Plate 6
- Plate 7
- Plate 8

NOTE: Arrow Show Approximate Direction of View of Photographs

REF: Duke Power Company Drawing Nos. Through (Latest Revisions Dated 6/30/77)& (Latest Revision Dated 6/19/)

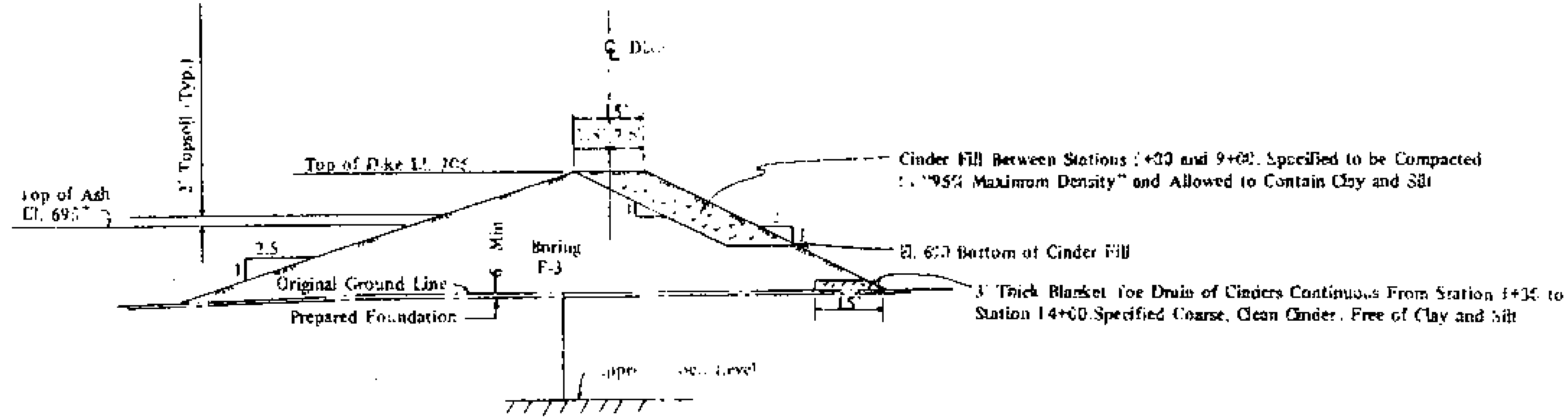
Approximate Scale, Ft.

0 50 100 200

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

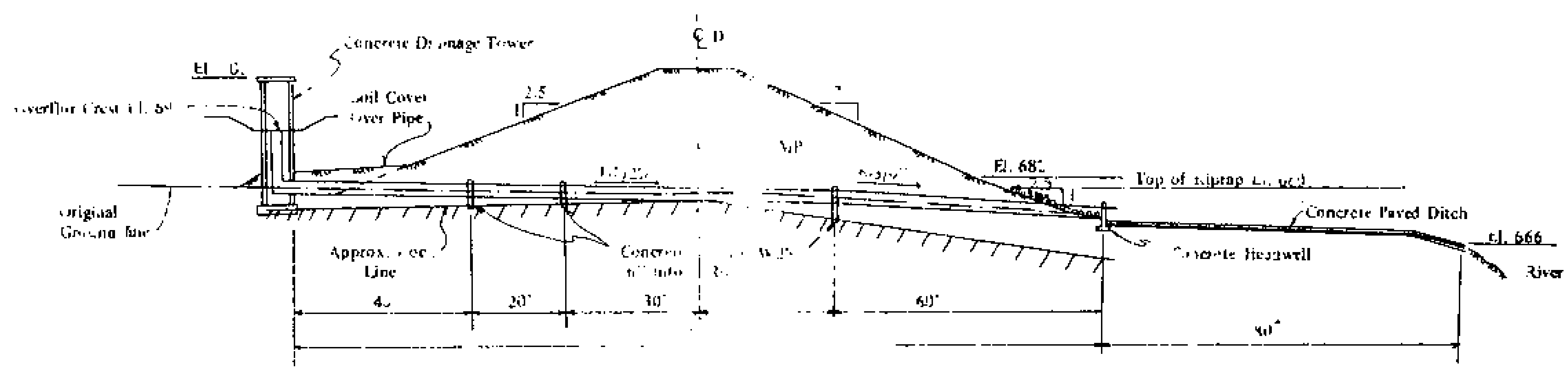
Plan of Units 1-4 Old Dike
Cliffside Units
Cleveland County, North Carolina

JOB NO	CH	FIGURE



SECTION A-A

SCALE 1" = 30



SECTION B-B

SCALE: 1" =

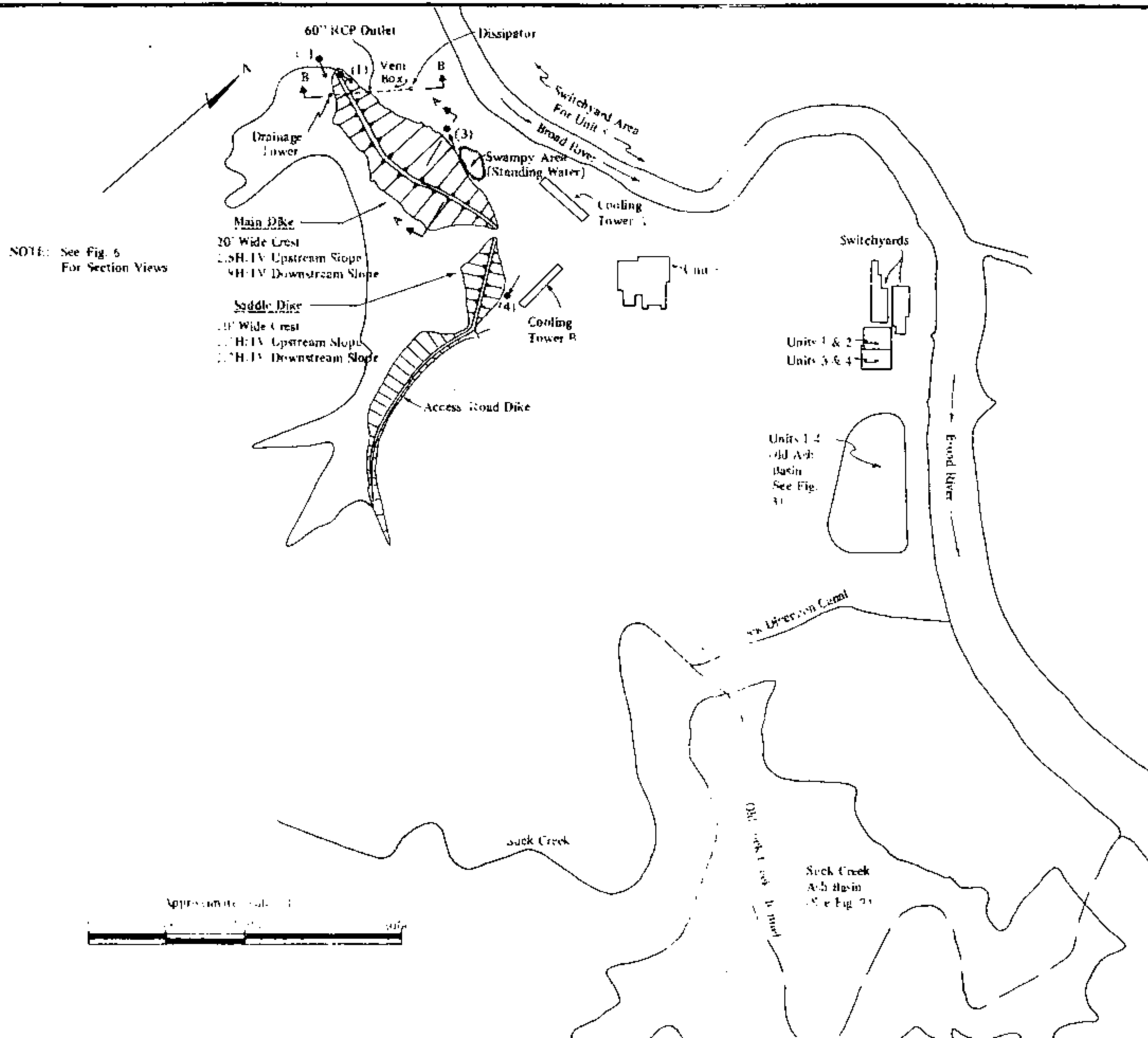
NOTE: See Fig. 3 For Location of Sections

R.F. Duke Power Company Drawing No. (Latest Revision Dated 6-30-77)

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Sections Through Units 1-4 Old Dike and Basin Outlet
Cliffside Units 1-4 Old Ash Storage Basin
Cleveland County, North Carolina

JOB NO. CH 4551	FIGURE 4



INDEX TO PHOTOGRAPHS

(1) Plate 9
(2) Plate 10
(3) Plate 11
(4) Plate 12

NOTE: Arrows (⟶) Show Approximate Direction of View of Photographs

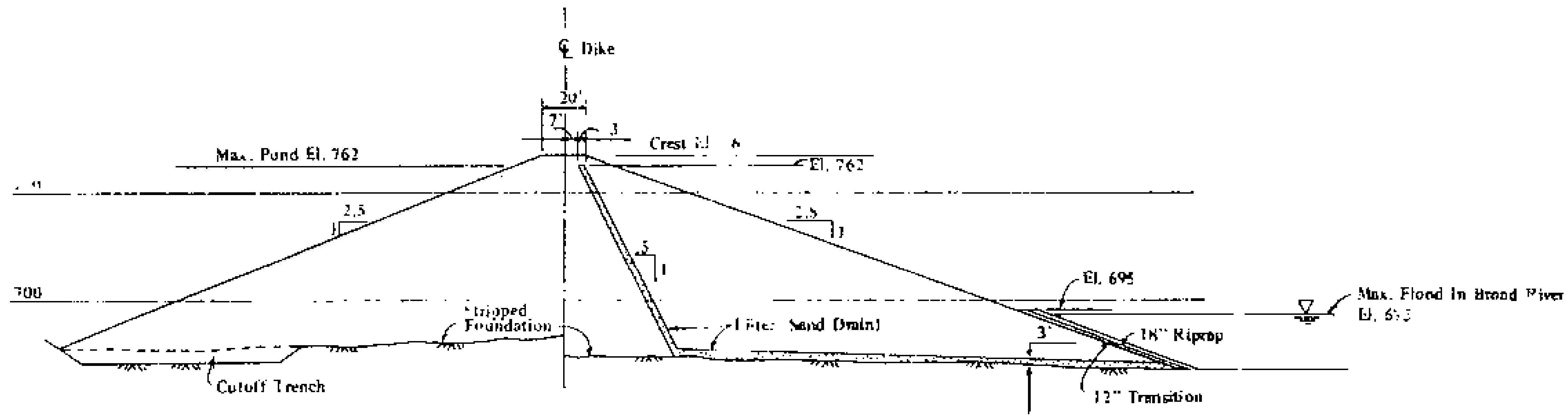
REF: Duke Power Company Drawing No. C-3-0 (by Bechtel Corporation)

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

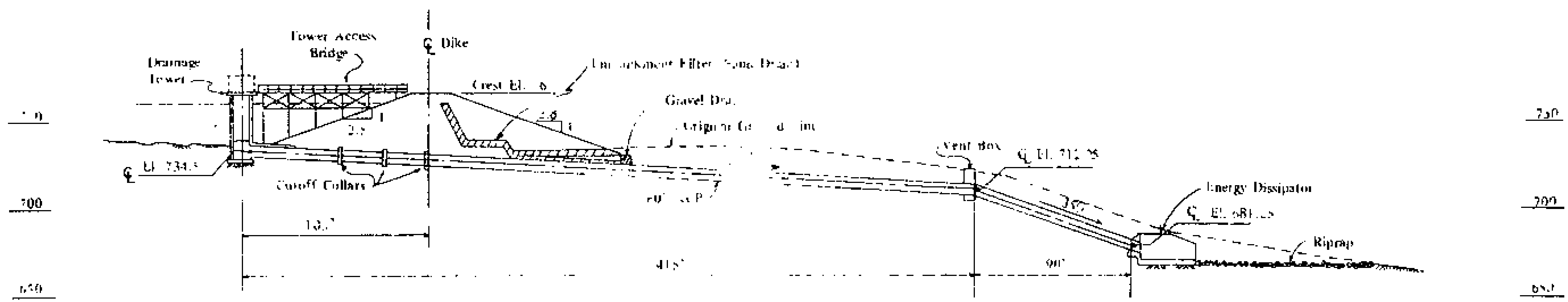
Plan of Unit 5 Old Dikes
Cliffside Unit 5 Old Ash Storage Basin
Cleveland County, North Carolina

JOB NO.

FIGURE



SECTION A-A

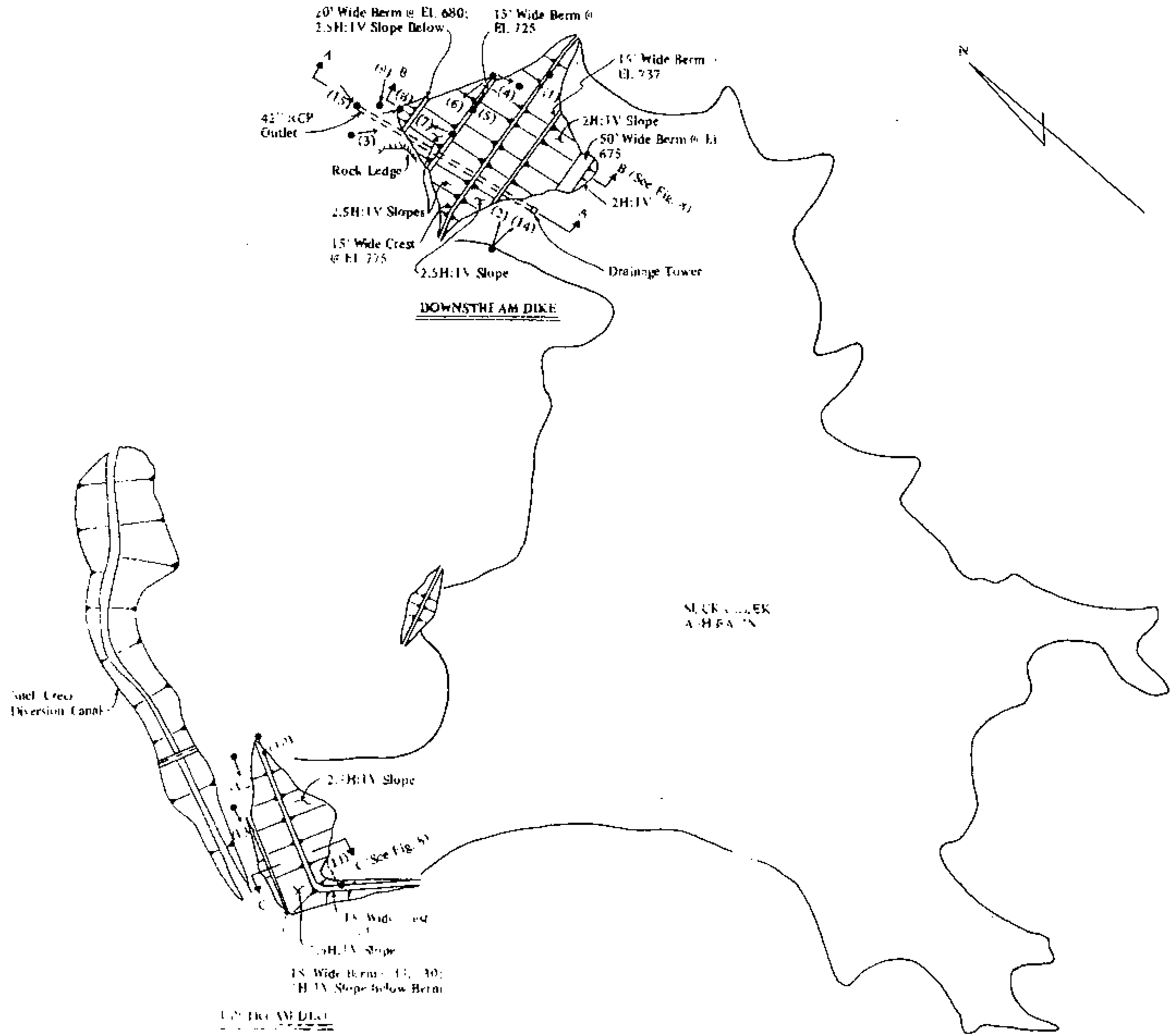


SECTION B-B

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

JOB NO.

FIGURE



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(11) Plate 23
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(13) Plate 25
(14) Plate 26
(15) Plate 27

NOTE: Arrows ( ) Show Approximate Direction of View of Photographs

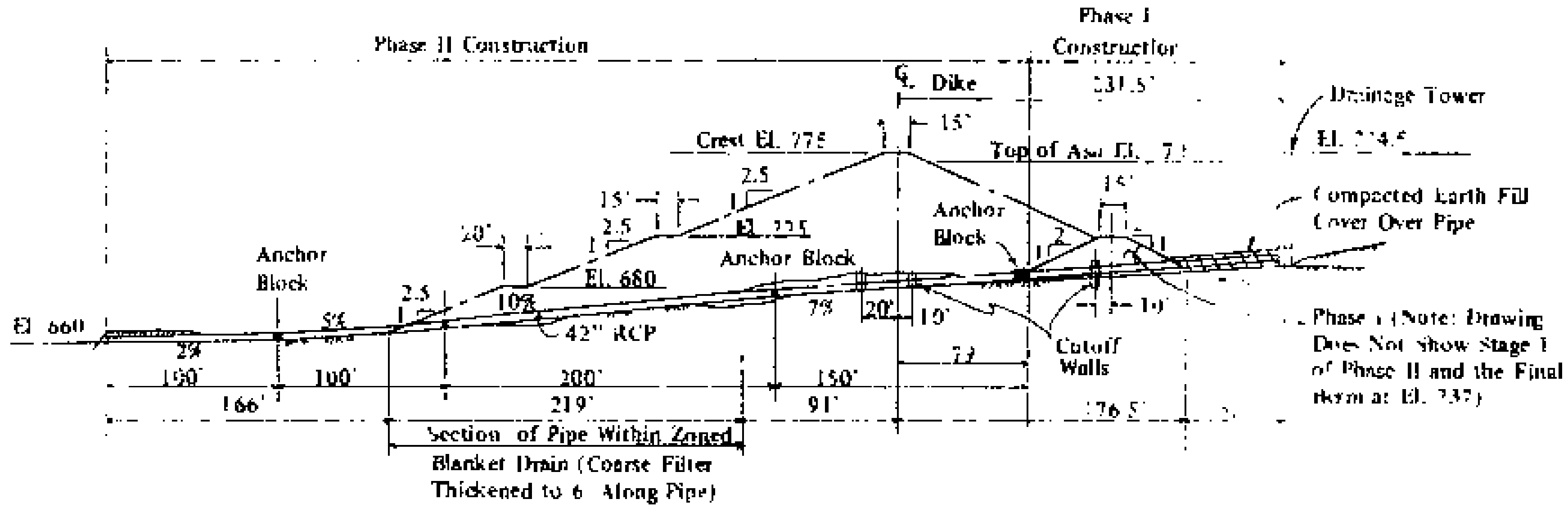
REF: Duke Power Company Drawing No. (Latest Revision Dated 4-17-81)

LAW ENGINEERING TESTING CO
CHARLOTTE, NORTH CAROLINA

Plan of Suck Creek Dikes
Cliffside Units 1-5 New Ash Storage Basin
Cleveland County, North Carolina

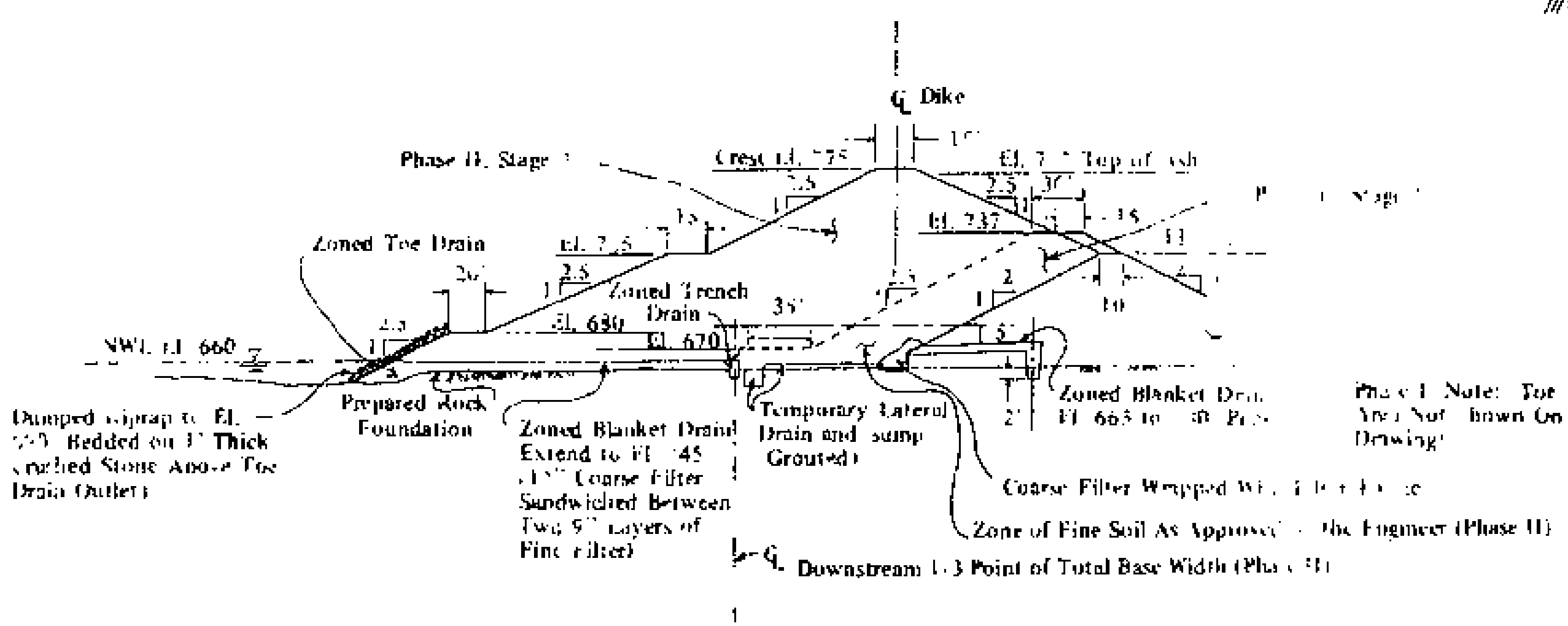
JOB NO. CH

FIGURE



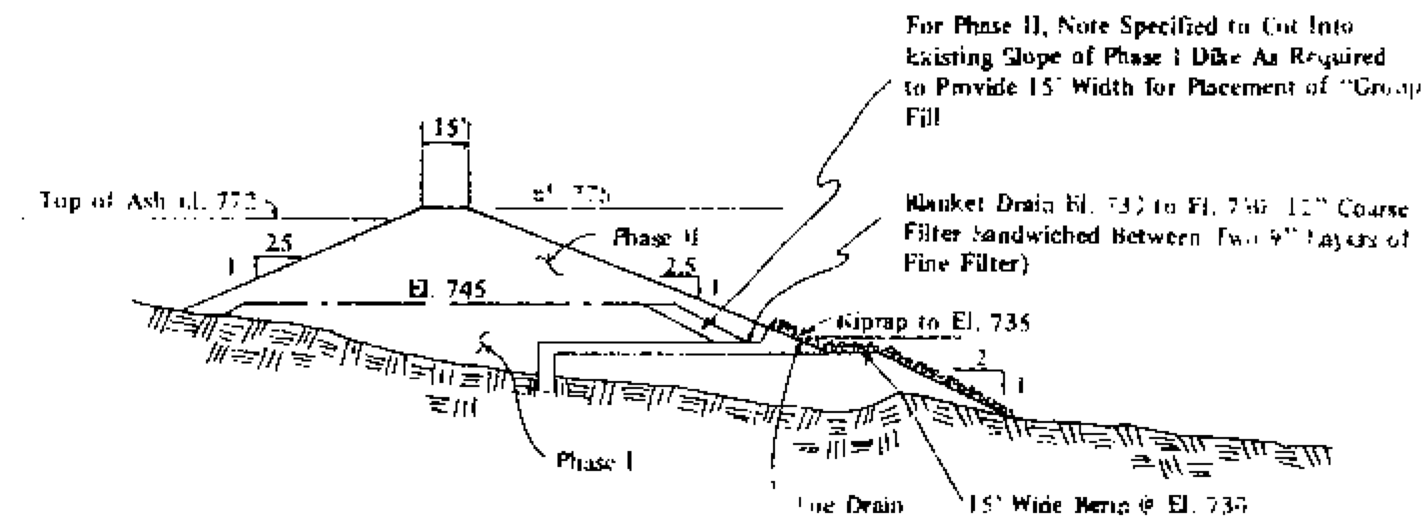
SECTION A-A

DOWNSTREAM DIKE AND OUTLET



SECTION B-B

DOWNSTREAM DIKE



SECTION C-C

UPSTREAM DIKE

NOTES: See Fig. for Location of Sections

REF: Duke Power Company Drawing Nos. C-2015A and C-2015B Both With Latest Revisions Dated

LAW ENGINEERING TESTING CO
CHARLOTTE, NORTH CAROLINA

Sections Through Suck Creek Dikes and Outlet
Cliffside Units New Ash Storage Basin
Cleveland County, North Carolina

JOB NO H

FIGURE

PLATE 1. - CREST OF UNITS 1-4 OLD BASIN DIKE

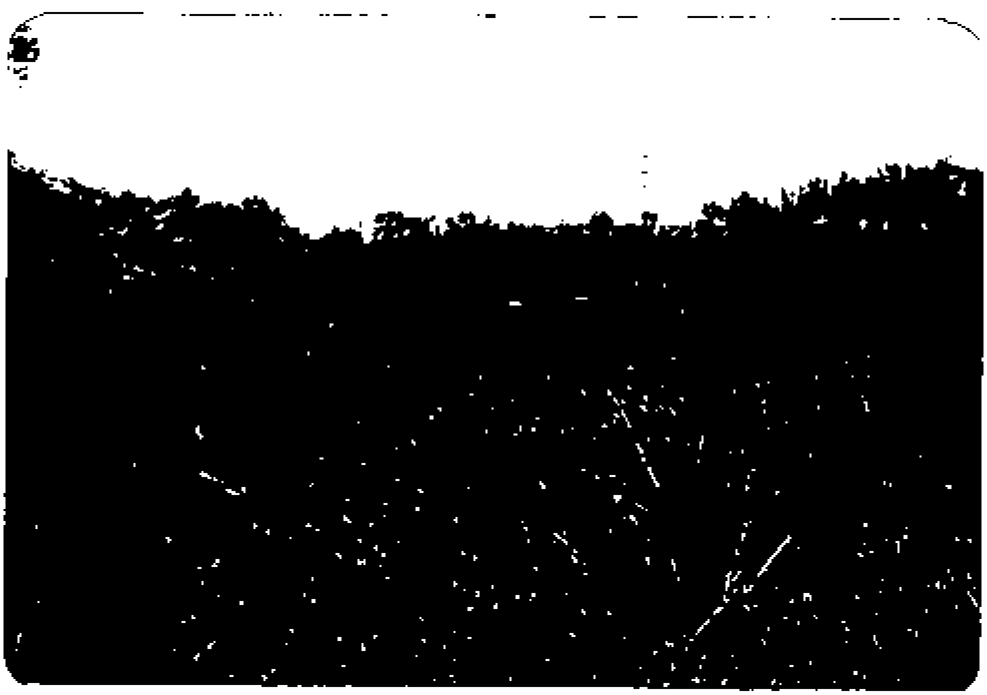


PLATE 2. - UPSTREAM SLOPE OF UNITS 1-4 OLD BASIN DIKE
(View From Inside of Basin)

PLATE 3. - YARD DRAINAGE HOLDING POND IN UNITS 1-4 OLD ASH BASIN AREA

PLATE 4. - DOWNSTREAM SLOPE OF UNITS 1-4 OLD BASIN DIKE

PLATE 7. - VIEW OF UNITS 1-4 OLD ASH BASIN DRAINAGE TOWER

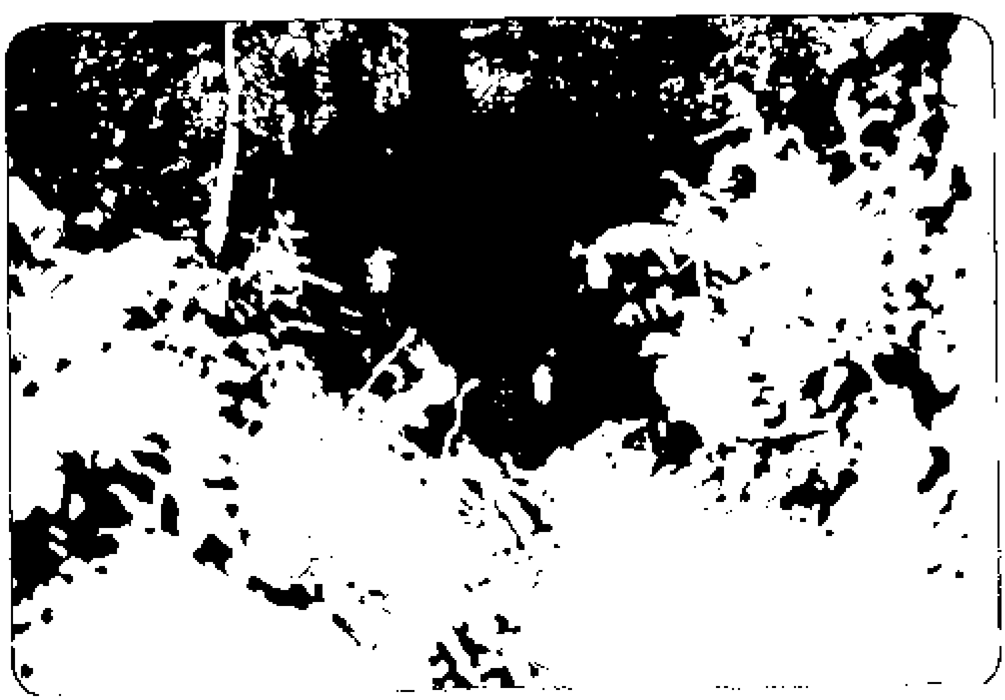


PLATE 8. - VIEW OF 30-INCH CMP OUTLET FOR UNITS 1-4 OLD ASH BASIN

PLATE 9. - DOWNSTREAM SLOPE OF UNIT 5 OLD BASIN MAIN DIKE

PLATE 10. - VIEW OF UNIT 5 OLD ASH BASIN AREA AND DRAINAGE TOWER

PLATE 11. - CLEAR SEEPAGE FLOW FROM DOWNSTREAM TOE OF UNIT 5 OLD BASIN MAIN DIKE

PLATE 12. - COLLECTED SEEPAGE WATER IN DRAINAGE DITCH BELOW DOWNSTREAM TOE OF UNIT 5 OLD BASIN SADDLE DIKE

PLATE 13. - CREST OF SUCK CREEK DOWNSTREAM DIKE

PLATE 14. - UPSTREAM SLOPE OF SUCK CREEK DOWNSTREAM DIKE

PLATE 15. - DOWNSTREAM SLOPE OF SUCK CREEK DOWNSTREAM DIKE

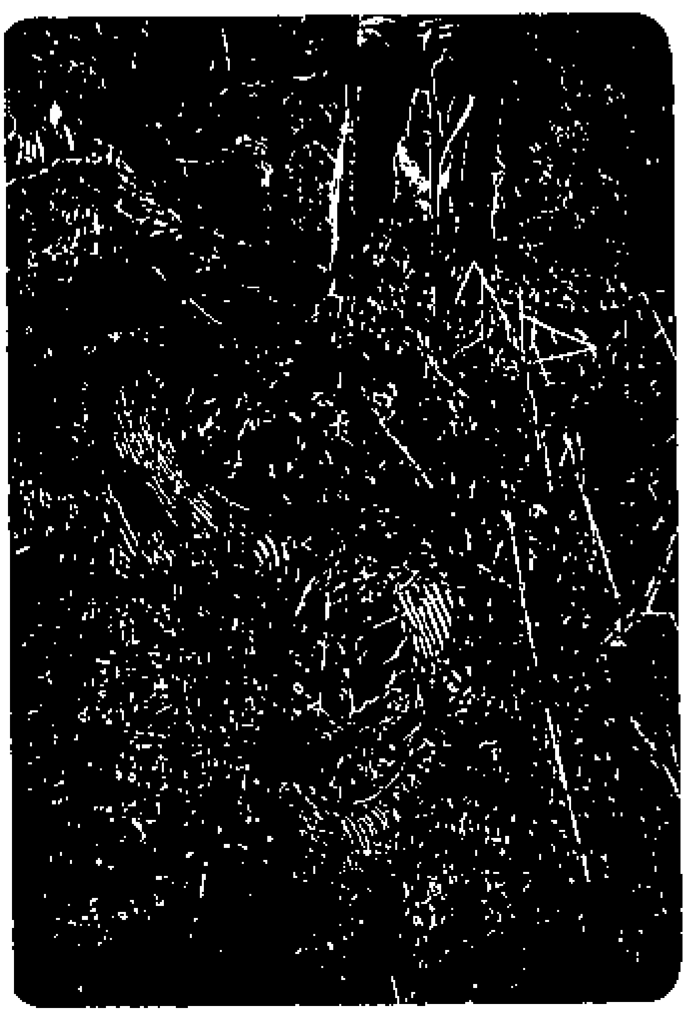


PLATE 16. - EROSION GULLY ON DOWNSTREAM SLOPE OF SUCK CREEK DOWNSTREAM DIKE

PLATE 17. - SILT ACCUMULATION ON UPPER BERM ON DOWNSTREAM SLOPE OF SUCK CREEK DOWNSTREAM DIKE

PLATE 18. - DOWNSTREAM SLOPE BETWEEN UPPER AND LOWER BERMS AND ROCK LEDGE AT LEFT ABUTMENT OF SUCK CREEK DOWNSTREAM DIKE

PLATE 19. - RIPRAPPED CHANNEL BELOW DOWNSTREAM TOE OF SUCK CREEK DOWNSTREAM DIKE

PLATE 20. - CLEAR SEEPAGE FLOW FROM DOWNSTREAM TOE OF SUCK CREEK DOWNSTREAM DIKE

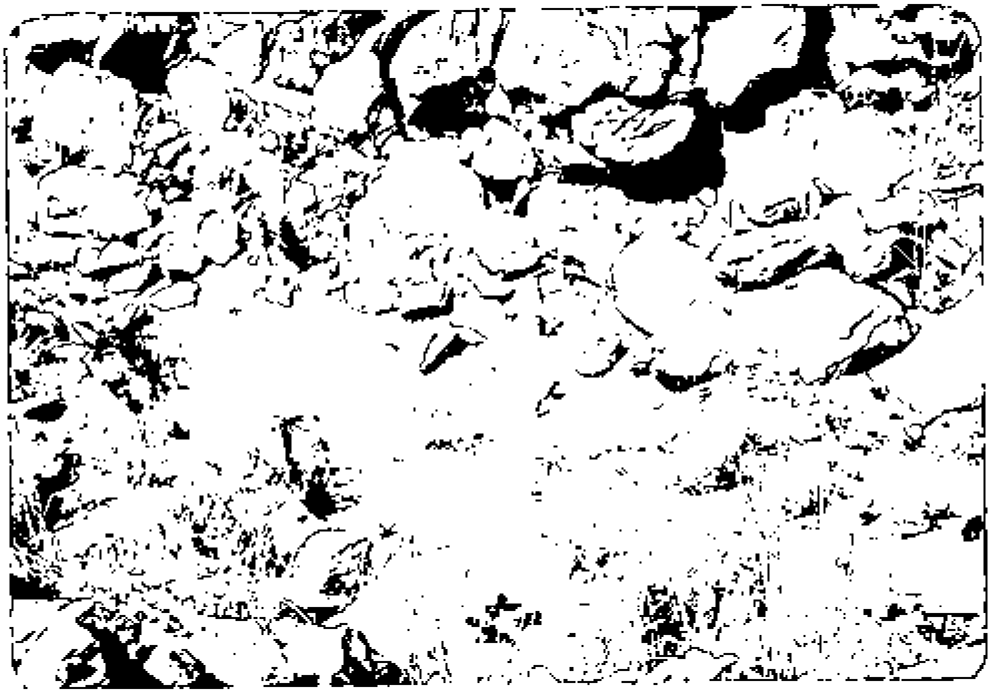


PLATE 21. - "RED" SEEP AT BASE OF WEST BANK OF CHANNEL BELOW SUCK CREEK DOWNSTREAM DIKE

PLATE 22. - CREST OF SUCK CREEK UPSTREAM DIKE

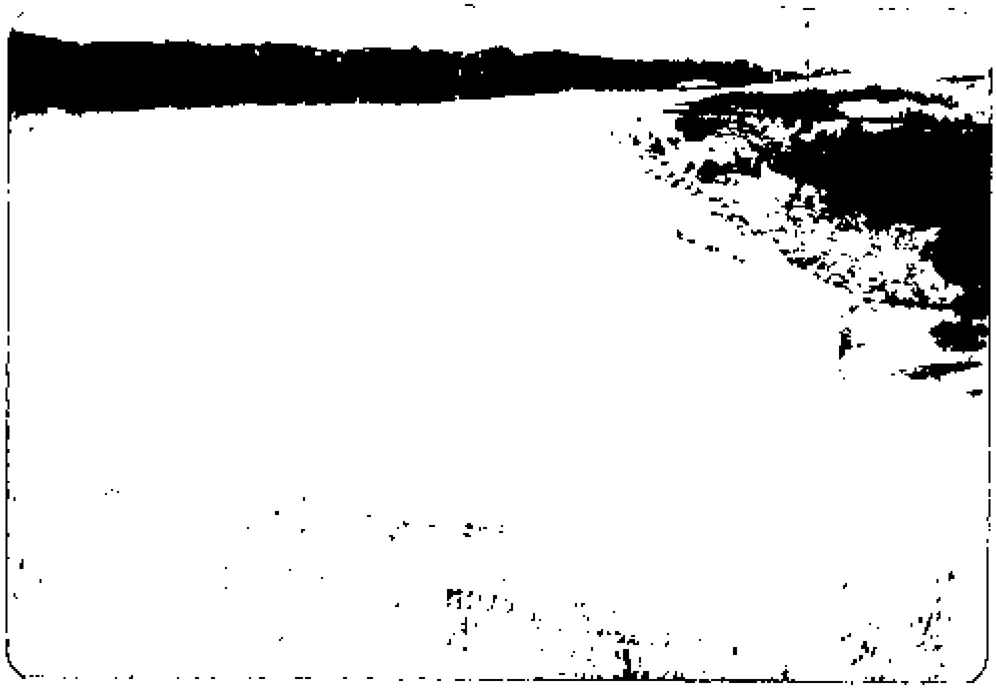


PLATE 23. - UPSTREAM (INSIDE) SLOPE OF SUCK CREEK UPSTREAM DIKE

PLATE 24. - DOWNSTREAM (OUTSIDE) SLOPE OF SUCK CREEK UPSTREAM DIKE

PLATE 25. - RIPRAPPED OUTSIDE TOE OF SUCK CREEK UPSTREAM DIKE

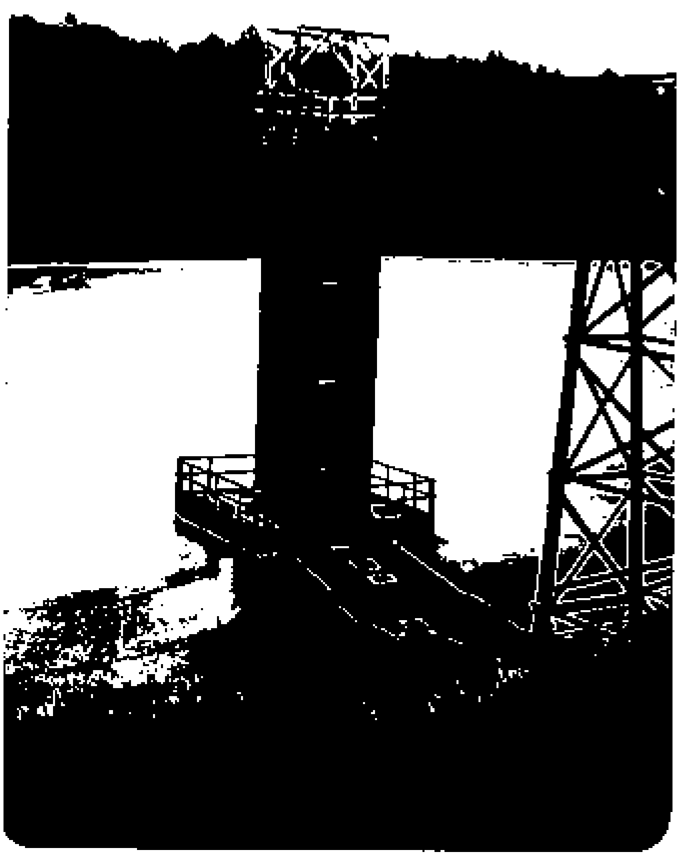


PLATE 26. - VIEW OF SUCK CREEK ASH BASIN DRAINAGE TOWER

PLATE 27. - VIEW OF 42-INCH RCP OUTLET FOR SUCK CREEK ASH BASIN

geotechnical, environmental & construction materials consultants

ANNUAL DAM INSPECTION CHECKLIST
Duke Energy
Program Engineering

NAME OF FACILITY: Cliffside Steam Station

LOCATION: Municipality: Mooresboro, NC County: Rutherford

CLASSIFICATION DATA: Size: 84 acres Hazard: High

PHYSICAL DATA: Suck Creek Dike (Upriver Dike)
Type of Dam: Earthen Height of Dam: 65 ft. Normal Pool Storage Capacity: 502 ac-ft

ELEVATIONS:
Normal Pool: 767 Pool at Inspection: 765.44 Tailwater at Inspection: N/A

DAM OWNER: Duke Energy - Steve Hodges **OPERATOR:** Duke Energy

ADDRESS: N/A

PHONE: ( ) N/A **FAX NO.:** ( ) N/A **E-MAIL ADDRESS:** N/A

PERSONS PRESENT AT INSPECTION:

Name	Title/Position	Representing
Steve Hodges	Sr. EHS Professional	EHS - Equipment Owner
Kelley Allison	Engineer II	Station Engineering
Henry Taylor P.E	Senior Engineer	Program Engineering

DATE OF INSPECTION: 11 / 17 / 09

WEATHER: Sunny

TEMPERATURE: 60° F

This is to certify that the above dam has been inspected and the following are the results of this inspection.

B. H. Taylor P.E. 11/17/09
Date

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
EMBANKMENT: CREST					
1	Surface Cracking		☐	☐	☐
2	Sinkhole, Animal Burrow		☐	☐	☐
3	Low Area(s)		☐	☐	☐
4	Horizontal Alignment		☐	☐	☐
5	Ruts and/or Puddles		☐	☐	☐
6	Vegetation Condition		☐	☐	☐
7	Warning Signs		☐	☐	☐
8			☐	☐	☐
9			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
EMBANKMENT: UPSTREAM FACE					
10	Slide, Slough, Scarp		☐	☐	☐
11	Slope Protection		☐	☐	☐
12	Sinkhole, Animal Burrow		☐	☐	☐
13	Emb.-Abut. Contact		☐	☐	☐
14	Erosion		☐	☐	☐
15	Vegetation Condition		☐	☐	☐
16			☐	☐	☐
17			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	EVALUATE
EMBANKMENT: DOWNSTREAM FACE					
18	Wet Area(s) (No Flow)		☐	☐	☐
19	Seepage	At toe in Wetlands	☒	☐	☐
20	Slide, Slough, Scarp		☐	☐	☐
21	Emb. - Abut. Contact		☐	☐	☐
22	Sinkhole, Animal Burrow	Fire Ants	☐	☒	☐
23	Erosion		☐	☐	☐
24	Unusual Movement		☐	☐	☐
25	Vegetation Control		☐	☐	☐
26	Slope Protection		☐	☐	☐
27			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	EVALUATE
EMBANKMENT: INSTRUMENTATION					
28	Piezometers/Observ. Wells		☐	☐	☐
29	Staff Gauge and Recorder		☐	☐	☐
30	Weirs		☐	☐	☐
31	Survey Monuments		☐	☐	☐
32	Drains		☐	☐	☐
33	Low Flow Release		☐	☐	☐
34	Frequency of Readings		☐	☐	☐
35	Location of Records		☐	☐	☐
36			☐	☐	☐
37			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
DOWNSTREAM AREA					
38	Abutment Leakage		☐	☐	☐
39	Foundation Seepage	Monitor at Toe (wetlands)	☒	☐	☐
40	Slide, Slough, Scarp		☐	☐	☐
41	Drainage System		☐	☐	☐
42	Boils		☐	☐	☐
43	Wet Areas *		☐	☐	☐
44	Reservoir Slopes		☐	☐	☐
45	Access Roads		☐	☐	☐
46	Security Devices		☐	☐	☐
47	Signs and Buoys		☐	☐	☐
48			☐	☐	☐
49			☐	☐	☐

Additional Comments (Refer to item number if applicable):

* It is desirable to have toe more ~~[illegible]~~ inspectable through wetlands at the toe; however, may do more harm than good if area is cleared. May still be too wet for mowers. See what Dam Safety says.

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
SPILLWAYS: ERODABLE CHANNEL					
50	Slide, Slough, Scarp		☐	☐	☐
51	Erosion		☐	☐	☐
52	Vegetation Condition		☐	☐	☐
53	Debris		☐	☐	☐
54			☐	☐	☐
55			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	EVALUATE
SPILLWAYS: NON-ERODABLE CHANNEL					
56	Sidewalls		☐	☐	☐
57	Channel Floor		☐	☐	☐
58	Unusual Movement		☐	☐	☐
59	Approach Area		☐	☐	☐
60	Weir or Control		☐	☐	☐
61	Discharge Channel		☐	☐	☐
62	Boils or Bimps		☐	☐	☐
63			☐	☐	☐
64			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	EVALUATE
SPILLWAYS: DROP INLET					
65	Intake Structure		☐	☐	☐
66	Trashrack		☐	☐	☐
67	Stilling Basin		☐	☐	☐
68			☐	☐	☐
69			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:	DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	EVALUATE
OUTLET WORKS					
70	Intake Structure		☐	☐	☐
71	Trashrack		☐	☐	☐
72	Stilling Basin		☐	☐	☐
73	Primary Closure		☐	☐	☐
74	Secondary Closure		☐	☐	☐
75	Control Mechanism		☐	☐	☐
76	Outlet Pipe		☐	☐	☐
77	Outlet Tower		☐	☐	☐
78	Outlet Structure		☐	☐	☐
79	Seepage		☐	☐	☐
80	Unusual Movement		☐	☐	☐
81			☐	☐	☐
82			☐	☐	☐

Additional Comments (Refer to item number if applicable):

RESERVOIR AREA

104	Sedimentation		☐	☐	☐
105	Slope Stability		☐	☐	☐
106	Sinkholes		☐	☐	☐
107	Fractures		☐	☐	☐
108	Unwanted Growth		☐	☐	☐
109	Storage Gage		☐	☐	☐
110			☐	☐	☐
111			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	EVALUATE

Final Comments:

DAM Inspection CHECKLIST
Duke Energy
Program Engineering

NAME OF DAM:

This is to certify that both the Downstream Hazard Description is accurate and the Posted Notice locations listed below have been inspected and the following are the results of these inspections.

Name of Dam Owner	Signature of Dam Owner	Date

This Dam Owners Notice Checklist is to accompany the Inspection Checklist filed by the Engineer.

EMERGENCY ACTION PLAN

Date of Last Update of Emergency Plan:

Downstream Hazard Description, additionally, specify any new developments, structures, etc. downstream within the inundation area:

Action Items

ITEM #	DATE INSPECTED	LOCATION	COMMENTS	EXISTING	MISSING	REPLACED
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐

Additional Comments (Refer to item number if applicable):

ANNUAL DAM INSPECTION CHECKLIST
Duke Energy
Program Engineering

NAME OF FACILITY: Cliffside Steam Station

LOCATION: Municipality: Mooresboro, NC County: Rutherford

CLASSIFICATION DATA: Size: 84 acres Hazard: High

PHYSICAL DATA: MAIN DIKE
Type of Dam: Earthen Height of Dam: 120 ft. Normal Pool Storage Capacity: 5028 ac-ft

ELEVATIONS:
Normal Pool: 767 Pool at Inspection: 765.44 Tailwater at Inspection: N/A

DAM OWNER: Duke Energy - Steve Hodges **OPERATOR:** Duke Energy

ADDRESS: N/A

PHONE: (___)- N/A **FAX NO.:** (___)- N/A **E-MAIL ADDRESS:** N/A

PERSONS PRESENT AT INSPECTION:

Name	Title/Position	Representing
Steve Hodges	Sr. EHS Professional	EHS - Equipment Owner
Kelley Allison	Engineer II	Station Engineering
Henry Taylor P.E.	Senior Engineer	Program Engineering

DATE OF INSPECTION: 11 / 17 / 09

WEATHER: Sunny

TEMPERATURE: 60° F

This is to certify that the above dam has been inspected and the following are the results of this inspection.

B. H. Taylor P.E. 11/17/09
Date

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
	EMBANKMENT: CREST				
1	Surface Cracking		☐	☐	☐
2	Sinkhole, Animal Burrow		☐	☐	☐
3	Low Area(s)		☐	☐	☐
4	Horizontal Alignment		☐	☐	☐
5	Ruts and/or Puddles		☐	☐	☐
6	Vegetation Condition		☐	☐	☐
7	Warning Signs		☐	☐	☐
8			☐	☐	☐
9			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
	EMBANKMENT: UPSTREAM FACE				
10	Slide, Slough, Scarp		☐	☐	☐
11	Slope Protection		☐	☐	☐
12	Sinkhole, Animal Burrow		☐	☐	☐
13	Emb.-Abut. Contact		☐	☐	☐
14	Erosion		☐	☐	☐
15	Vegetation Condition		☐	☐	☐
16			☐	☐	☐
17			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
EMBANKMENT: DOWNSTREAM FACE					
18	Wet Area(s) (No Flow)	R+L near groins, above bench	☒	☐	☐
19	Seepage	Toe	☒	☐	☐
20	Slide, Slough, Scarp		☐	☐	☐
21	Emb. - Abut. Contact		☐	☐	☐
22	Sinkhole, Animal Burrow		☐	☐	☐
23	Erosion		☐	☐	☐
24	Unusual Movement		☐	☐	☐
25	Vegetation Control	Standing water at bench @ Left groin	☒	☐	☐
26	Slope Protection		☐	☐	☐
27			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
EMBANKMENT: INSTRUMENTATION					
28	Piezometers/Observ. Wells		☐	☐	☐
29	Staff Gauge and Recorder		☐	☐	☐
30	Weirs		☐	☐	☐
31	Survey Monuments		☐	☐	☐
32	Drains		☐	☐	☐
33	Low Flow Release		☐	☐	☐
34	Frequency of Readings		☐	☐	☐
35	Location of Records		☐	☐	☐
36			☐	☐	☐
37			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:	DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
DOWNSTREAM AREA					
38	Abutment Leakage		☐	☐	☐
39	Foundation Seepage	Bottom of Dike, Toe	☒	☐	☐
40	Slide, Slough, Scarp		☐	☐	☐
41	Drainage System		☐	☐	☐
42	Boils		☐	☐	☐
43	Wet Areas		☐	☐	☐
44	Reservoir Slopes		☐	☐	☐
45	Access Roads		☐	☐	☐
46	Security Devices		☐	☐	☐
47	Signs and Buoys		☐	☐	☐
48			☐	☐	☐
49			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
SPILLWAYS: ERODABLE CHANNEL					
50	Slide, Slough, Scarp		☐	☐	☐
51	Erosion		☐	☐	☐
52	Vegetation Condition		☐	☐	☐
53	Debris		☐	☐	☐
54			☐	☐	☐
55			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
SPILLWAYS: NON-ERODABLE CHANNEL					
56	Sidewalls		☐	☐	☐
57	Channel Floor		☐	☐	☐
58	Unusual Movement		☐	☐	☐
59	Approach Area		☐	☐	☐
60	Weir or Control		☐	☐	☐
61	Discharge Channel		☐	☐	☐
62	Boils or Bimps		☐	☐	☐
63			☐	☐	☐
64			☐	☐	☐

Additional Comments (Refer to item number if applicable):

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
SPILLWAYS: DROP INLET					
65	Intake Structure		☐	☐	☐
66	Trashrack		☐	☐	☐
67	Stilling Basin		☐	☐	☐
68			☐	☐	☐
69			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate
		OUTLET WORKS			
70	Intake Structure		☐	☐	☐
71	Trashrack		☐	☐	☐
72	Stilling Basin		☐	☐	☐
73	Primary Closure		☐	☐	☐
74	Secondary Closure		☐	☐	☐
75	Control Mechanism		☐	☐	☐
76	Outlet Pipe		☐	☐	☐
77	Outlet Tower		☐	☐	☐
78	Outlet Structure	Undermining of Concrete on R of Outlet	☒	☐	☐
79	Seepage		☐	☐	☐
80	Unusual Movement		☐	☐	☐
81			☐	☐	☐
82			☐	☐	☐

Additional Comments (Refer to item number if applicable):

RESERVOIR AREA

104	Sedimentation		☐	☐	☐
105	Slope Stability		☐	☐	☐
106	Sinkholes		☐	☐	☐
107	Fractures		☐	☐	☐
108	Unwanted Growth		☐	☐	☐
109	Storage Gage		☐	☐	☐
110			☐	☐	☐
111			☐	☐	☐

Additional Comments (Refer to item number if applicable):

NAME OF DAM:		DATE:

ITEM	CONDITION	COMMENTS	MONITOR	REPAIR	Evaluate

Final Comments:

DAM Inspection CHECKLIST
Duke Energy
Program Engineering

NAME OF DAM:	

This is to certify that both the Downstream Hazard Description is accurate and the Posted Notice locations listed below have been inspected and the following are the results of these inspections.

Name of Dam Owner	Signature of Dam Owner	Date

This Dam Owners Notice Checklist is to accompany the Inspection Checklist filed by the Engineer.

EMERGENCY ACTION PLAN

Date of Last Update of Emergency Plan:	

Downstream Hazard Description, additionally, specify any new developments, structures, etc. downstream within the inundation area:

Action Items

ITEM #	DATE INSPECTED	LOCATION	COMMENTS	EXISTING	MISSING	REPLACED
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐
				☐	☐	☐

Additional Comments (Refer to item number if applicable):

DUKE ENERGY
MONTHLY DAM INSPECTION CHECKLIST

NAME OF STATION: Cliffside Steam Station **COUNTY, ST:** Cleveland Co, NC
INSPECTOR: Steve Hodges & Joshua Moore **INSPECTION DATE:** 1/31/11
WEATHER: Sunny / overcast **AMT OF RAINFALL IN LAST 24 HOURS:** NONE

Pool Level
Primary Pond Level: Pond Reading 33.5
764.61

Main Dike						
Interior Slope	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there any cracks, slides or erosion?	☐	☒	☐	☐	☐	☐
Are there any rodent burrows or depressions?	☐	☒	☐	☐	☐	☐
Is there vegetation or sediment in the riprap?	☐	☒	☐	☐	☐	☐
Is there vegetation over 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments:						
Crest	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there large cracks?	☐	☒	☐	☐	☐	☐
Are there low areas or potholes?	☐	☒	☐	☐	☐	☐
Is there vegetation greater than 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments:						
Exterior Slope	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there cracks, slides or erosion?	☐	☒	☐	☐	☐	☐
Are there rodent burrows or depressions?	☐	☒	☐	☐	☐	☐
Is the grass cover in good condition?	☒	☐	☐	☐	☐	☐
Are there areas of seepage?	☐	☒	☐	☐	☐	☐
Is there vegetation greater than 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments:						
Outlet Structure	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are the valves and operators in good condition?	☐	☐	☒	☐	☐	☐
Is the system operable?	☒	☐	☐	☐	☐	☐
Is the outlet structural material in good condition?	☒	☐	☐	☐	☐	☐
Is the walkway to the outlet in good condition?	☒	☐	☐	☐	☐	☐
Comments:						
NCDENR Recommendations						
Observations and Routine Inspections	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**

Observation of wetness of surface of dam embankment. Please see NCDENR report CLEVE-049 dated April 6, 2010. Areas should be monitored with respect to wetness of areas. Are any of these areas change in volume and/or color of wetness? (If yes, please describe in comment box below)	☐	☒	☐	☐	☐	☐
Comments:						
Observation of irregularities. Bulges were observed on the upstream slope and downstream slopes. They appeared to be stable at time of inspection but should be observed. Have these areas shown any sign of change? (If yes, please describe in comment box below)	☐	☒	☐	☐	☐	☐
Comments:						
Observation of sedimentation at embankment drain discharge channel. This area was cleaned out but needs to be regularly inspected for sedimentation deposits and also the discharge pipe running along embankment, especially when river raises in elevation. Are there any changes in sedimentation? (If yes, please describe in comment box below)	☒	☐	☐	☐	☐	☐
Comments: Silt and leaves were deposited at river ~~end~~ edge. Seepage is normal and a small channel goes thru the silt/leaves						
Suck Creek Dam						
Interior Slope	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there any cracks, slides or erosion?	☐	☒	☐	☐	☐	☐
Are there any rodent burrows or depressions?	☐	☒	☐	☐	☐	☐
Is there vegetation or sediment in the riprap?	☐	☒	☐	☐	☐	☐
Is there vegetation greater than 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments: Small area where equipment in '09 was stuck was repaired to smooth out the dam inner face						
Crest	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there large cracks?	☐	☒	☐	☐	☐	☐
Are there low area or potholes?	☐	☒	☐	☒	☐	☐
Is there vegetation greater than 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments: Road on south side was soft, Evaluate + monitor for additional stone						
Exterior Slope	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there cracks, slides or erosion?	☐	☒	☐	☐	☐	☐
Are there rodent burrows or depressions?	☐	☒	☐	☒	☐	☐
Is the grass cover in good condition?	☒	☐	☐	☐	☐	☐
Are there areas of seepage? Normal Area	☒	☐	☐	☐	☐	☐

	Yes	No	N/A	Monitor	Repair	Evaluate
Is there vegetation greater than 2 inch diameter?		X				

Comments: Beavers have built small dam at toe of dam to stop the seepage from draining

NCDENR Recommendations

Observations and Routine Inspections	Yes	No	N/A	Monitor	Repair	Evaluate
Seepage noted near rip rap toe. Are there any changes in quantity?		X				
Wetness observed on downstream slope. Are there any changes in degree and extent of wetness?		X				

Comments: Seepage same

Retired Ash Basin 1-4

Interior Slope	Yes	No	N/A	Monitor	Repair	Evaluate
Are there any cracks, slides or erosion?		X				
Are there any rodent burrows or depressions?		X				
Is there vegetation or sediment in the riprap?		X				
Is there vegetation greater than 2 inch diameter?	X					

Comments: Normal trees at fence.

Crest	Yes	No	N/A	Monitor	Repair	Evaluate
Are there large cracks?		X				
Are there low areas or potholes?		X				
Is there vegetation greater than 2 inch diameter?		X				

Comments:

Exterior Slope	Yes	No	N/A	Monitor	Repair	Evaluate
Are there cracks, slides or erosion		X				
Are there rodent burrows or depressions?		X				
Is the grass cover in good condition?	X					
Are there areas of seepage?		X				
Is there vegetation greater than 2 inch diameter?	X					

Comments: Large trees on dike. No small trees less than 6".

Retired Unit 5 Basin

Interior Slope	Yes	No	N/A	Monitor	Repair	Evaluate
Are there any cracks, slides or erosion?		X				
Are there any rodent burrows or depressions?		X				
Is there vegetation or sediment in the riprap?		X				
Is there vegetation greater than 2 inch diameter?		X				

Comments:

Crest	Yes	No	N/A	Monitor	Repair	Evaluate
Are there large cracks?	☐	☒	☐	☐	☐	☐
Are there low areas or potholes?	☐	☒	☐	☐	☐	☐
Is there vegetation greater than 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments:						
Exterior Slope	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are there cracks, slides or erosion	☐	☒	☐	☐	☐	☐
Are there rodent burrows or depressions?	☐	☒	☐	☐	☐	☐
Is the grass cover in good condition?	☒	☐	☐	☐	☐	☐
Are there areas of seepage?	☐	☒	☐	☐	☐	☐
Is there vegetation greater than 2 inch diameter?	☐	☒	☐	☐	☐	☐
Comments: Seepage only at toe, Beavers have built dam and holding back water at the toe.						
Outlet Structure	**Yes**	**No**	**N/A**	**Monitor**	**Repair**	**Evaluate**
Are the valves and operators in good condition?	☐	☐	☒	☐	☐	☐
Is the system operable?	☒	☐	☐	☐	☐	☐
Is the outlet structural material in good condition?	☒	☐	☐	☐	☐	☐
Is the walkway to the outlet in good condition?	☐	☒	☐	☐	☐	☐
Comments:						

2" Rainfall Inspection	Yes/No	Date(s)	Comments
Has a 2" rain event occurred during the month	NO		

SIGNATURE Steve Hodges
DATE 1-31-11

I hereby certify that I have reviewed the following checklist and have taken the appropriate action(s) to remediate any areas that may cause harm to the structural integrity of the dam.

REVIEWED BY ______________________
DATE ______________________

NCDENR

North Carolina Department of Environment and Natural Resources

Division of Land Resources

Land Quality Section

James D. Simons, PG, PE
Director and State Geologist

Beverly Eaves Perdue, Governor
Dee Freeman, Secretary

NOTICE OF INSPECTION

November 24, 2010

Duke Energy Corporation
Attention: Mr. B. Henry Taylor, PE, Senior Engineer - EC11J
Post Office Box 1006
Charlotte, North Carolina 28201-1006

RE: Cliffside Active Ash Basin Downstream Dam
Cleveland County
CLEVE-049-H
Broad River Basin

Dear Mr. Taylor:

The "Dam Safety Law of 1967," as amended, provides for the certification and inspection of dams in the interest of public health, safety, and welfare, in order to reduce the risk of failure of dams; to prevent injuries to persons, damage to property; and to insure the maintenance of stream flows.

Our records indicate that you are the owner and/or are responsible for the referenced dam, which is located off McCraw Road in Cleveland County and was inspected on November 18, 2010 by Land Quality Section staff of the Mooresville Regional Office. This inspection revealed the condition outlined below which could lead to serious problems in the future, including failure of the dam. Please note that "right" and "left" in descriptions of the dam are referenced facing downstream.

1. Clear, concentrated seepage was observed in the rip rap toe protection. At the time of our inspection, the seepage appeared to originate from at least three locations, and has, according to Duke Energy personnel, been measured to be approximately 40 gpm. This seepage should be monitored regularly; any changes in quantity and/or clarity of the seepage flow should be reported to this office promptly.

Additionally, the following general maintenance procedures are recommended:

2. Periodically observe areas of wetness on the surface of the dam embankment. Several areas with soft soils and/or wetness previously observed on the embankment slope appeared to be drier. All wet areas should be monitored with respect to the extent of wetness, and care

should be taken to maintain a vigorous vegetative cover in these areas and to avoid excessive rutting or other damage from maintenance equipment.

3. Periodically observe the embankment drain discharge channel. Sediment deposits from the Broad River should be removed from this channel as necessary to retain a free-flowing condition for the embankment drain seepage discharges.

4. Periodically observe surface irregularities. A bulge was previously observed on the upstream slope at approximate lat/long 35.2171, -81.7346, and a shallow rill was previously noted on the downstream slope at 35.2174, -81.7478. Both of these irregularities appeared unchanged at the November 18, 2010 inspection. All surface irregularities should be noted and observed for movement or changes in shape or size.

5. Periodically apply grass seed and appropriate soil amendments to the dam embankment.

6. Periodically inspect the dam embankment for undesirable animal activity.

During this inspection we also investigated the potential for property damage and loss of life in the event that the subject dam fails. This investigation determined that failure of the dam could result in severe property damage and/or possible loss of life downstream. We are therefore retaining this dam in the "High Hazard Potential" category due to the likelihood of significant environmental damage to the Broad River. Please be advised that hazard potential classifications are subject to revision due to changes in downstream conditions.

Please also be advised that the Division of Land Resources must approve any excavation, modification, or repair work to this dam before the work commences. Also, note that this dam may not be breached, meaning the dam may not be drained by cutting a notch in the dam, without prior engineered breach plans being submitted to and approved by the Division of Land Resources.

As a dam owner, you may incur liability should your dam have a problem or fail, if such an event results in loss of life or property damage downstream. It is therefore requested that you continue to work with our Central Office Staff to develop an Emergency Action Plan (EAP) for this dam.

Although every reasonable effort is made to determine the safety of each dam, our resources generally limit us to a surficial inspection of the dam and its appurtenant structures. This letter carries no implication regarding the internal stability of the dam. Dams, and especially their spillways and conduits, deteriorate with age. You are therefore advised to keep a close watch on the dam and to notify us if you detect any changes, especially cracks, ground movements, or changes in seepage rate or color.

Your cooperation and consideration in maintaining a safe dam is appreciated. If an emergency situation develops during non-working hours, please notify 911 and the State Emergency Operations Center at 1 (800) 858-0368, who will notify the appropriate personnel in this Office. In order to help us keep our records current and serve you better, please notify us of any changes in ownership. Should you have any questions concerning our inspection, please contact Mr. Zahid S. Khan, Regional Engineer or me at telephone number (704) 663-1699.

Sincerely,

Scott Harrell

A. Scott Harrell, PE
Acting Regional Engineer

ASH/

cc: Mr. Robert Krebs, Surface Water Protection Regional Supervisor

FILENAME: CLEVE-049H (Cliffside Active Ash Basin Downstream Dam) 20101124_NOI

NCDENR

North Carolina Department of Environment and Natural Resources

Division of Land Resources

Land Quality Section

James D. Simons, PG, PE
Director and State Geologist

Beverly Eaves Perdue, Governor
Dee Freeman, Secretary

NOTICE OF INSPECTION

November 24, 2010

Duke Energy Corporation
Attention: Mr. B. Henry Taylor, PE, Senior Engineer EC11J
Post Office Box 1006
Charlotte, North Carolina 28201-1006

RE: Cliffside Active Ash Basin Upstream Dam
Cleveland County
CLEVE-050-H
Broad River Basin

Dear Mr. Taylor:

The "Dam Safety Law of 1967," as amended, provides for the certification and inspection of dams in the interest of public health, safety, and welfare, in order to reduce the risk of failure of dams; to prevent injuries to persons, damage to property; and to insure the maintenance of stream flows.

Our records indicate that you are the owner and/or are responsible for the referenced dam, which is located off McCraw Road in Cleveland County and was inspected on November 18, 2010 by Land Quality Section staff of the Mooresville Regional Office. This inspection revealed the conditions outlined below which could lead to serious problems in the future, including failure of the dam. Please note that "right" and "left" in descriptions of the dam are referenced facing downstream.

1. An area of recent repair was observed on the upstream slope during our previous inspection of this dam (February 23, 2010). According to facility personnel, this area was damaged by construction equipment during ash removal from within the basin. The damaged area, which is approximately 30 feet long and extends from the embankment crest to the water level, was stabilized with seed, mulch, and synthetic matting, but did not appear to have been restored to the original embankment cross-section dimensions. The area is located at approximate latitude/longitude 35.2141, -81.7555.

   It is requested that the dates of the damage and repair to the upstream slope, along with the methods and materials of repair, be documented in the form of a letter report and submitted to the Land Quality Section Mooresville Regional Office. It is also requested that Duke

Mooresville Regional Office
610 East Center Avenue, Suite 301, Mooresville, North Carolina 28115 • Phone: 704-663-1699

Energy evaluate whether the reduced embankment section at this location represents a significant reduction in embankment stability.

2. Concentrated seepage was observed in the rip rap toe protection at approximate lat/long 35.2139, -81.7561. This seepage should be monitored regularly; any changes in quantity and/or clarity of the seepage flow should be reported to this office promptly.

Additionally, the following general maintenance procedures are recommended:

3. Periodically observe areas of wetness on the surface of the dam embankment. An area of wetness previously observed on the embankment slope appeared to be drier. Any such areas should be monitored with respect to the extent of wetness, and care should be taken to maintain a vigorous vegetative cover in these areas and to avoid excessive rutting or other damage from maintenance equipment.

4. Periodically apply grass seed and appropriate soil amendments to the dam embankment.

5. Periodically inspect the dam embankment for undesirable animal activity.

During this inspection we also investigated the potential for property damage and loss of life in the event that the subject dam fails. This investigation determined that failure of the dam could result in severe property damage and/or possible loss of life downstream. We are therefore retaining this dam in the "High Hazard Potential" category due to the likelihood of significant environmental damage to the Broad River. Please be advised that hazard potential classifications are subject to revision due to changes in downstream conditions.

Please also be advised that the Division of Land Resources must approve any excavation, modification, or repair work to this dam before the work commences. Also, note that this dam may not be breached, meaning the dam may not be drained by cutting a notch in the dam, without prior engineered breach plans being submitted to and approved by the Division of Land Resources.

As a dam owner, you may incur liability should your dam have a problem or fail, if such an event results in loss of life or property damage downstream. It is therefore requested that you continue to work with our Central Office Staff to develop an Emergency Action Plan (EAP) for this dam.

Although every reasonable effort is made to determine the safety of each dam, our resources generally limit us to a surficial inspection of the dam and its appurtenant structures. This letter carries no implication regarding the internal stability of the dam. Dams, and especially their spillways and conduits, deteriorate with age. You are therefore advised to keep a close watch on the dam and to notify us if you detect any changes, especially cracks, ground movements, or changes in seepage rate or color.

Your cooperation and consideration in maintaining a safe dam is appreciated. If an emergency situation develops during non-working hours, please notify 911 and the State Emergency Operations Center at 1 (800) 858-0368, who will notify the appropriate personnel in this Office. In order to help us keep our records current and serve you better, please notify us of any changes in ownership. Should you have any questions concerning our inspection, please contact Mr. Zahid S. Khan, Regional Engineer or me at telephone number (704) 663-1699.

Sincerely,

Scott Harrell

A. Scott Harrell, PE
Acting Regional Engineer

ASH/

cc: Mr. Robert Krebs, Surface Water Protection Regional Supervisor

FILENAME: CLEVE-050H (Cliffside Active Ash Basin Upstream Dam) 20101124 NOI

LAW ENGINEERING
TESTING COMPANY

DUKE POWER COMPANY

CLIFFSIDE STEAM STATION
ASH BASIN DIKES
CLEVELAND AND RUTHERFORD COUNTIES, NORTH CAROLINA
LETCo. Job No. CHW 5475

SECOND FIVE-YEAR INDEPENDENT CONSULTANT INSPECTION
AS REQUIRED BY
NORTH CAROLINA UTILITIES COMMISSION

JULY, 1986

LAW ENGINEERING TESTING COMPANY
geotechnical, environmental & construction materials consultants
501 MINUET LANE
P.O. BOX 11297 • CHARLOTTE, NORTH CAROLINA 28220
(704) 523-2022

July 10, 1986

Mr. S. B. Hager, Chief Engineer
Duke Power Company
Civil/Environmental Division
P. O. Box 33189
Charlotte, North Carolina 28242

Attention: Mr. R. S. Bhatnager, Senior Engineer

Subject: Five-Year Independent Consultant Inspection
Cliffside Steam Station
Ash Basin Dikes
Cleveland and Rutherford Counties, North Carolina
Per North Carolina Utilities Commission
LETCo. Job No. CHW 5475

Gentlemen:

Law Engineering Testing Company is pleased to submit the following report of our independent inspection of the ash basin dikes at the Cliffside Steam Station. The inspection was performed in accordance with Duke Power Company's Specification No. SSS-0502-02 "Specifications for Inspection of Facilities as Required by the North Carolina Utilities Commission" dated February 14, 1986 and as authorized by Duke's letter dated March 20, 1986. Our inspection reported herein is the second five-year independent consultant inspection of the Cliffside Ash Basin Dikes.

In general, our inspection noted no external, presently visible signs of serious conditions requiring emergency repairs for public safety. Other than routine maintenance, no major repairs appear warranted at this time.

We appreciate the opportunity to provide our professional services to you on this project. Please let us know if you have any questions.

Very truly yours,

LAW ENGINEERING TESTING COMPANY

Fred C. Tucker

Fred C. Tucker, P. E.
Senior Geotechnical Engineer

Clay E. Sams

Clay E. Sams, P. E.
Geotechnical Consultant

FCT/CES:tmc
Attachments

DUKE POWER COMPANY

CLIFFSIDE STEAM STATION
ASH BASIN DIKES
CLEVELAND AND RUTHERFORD COUNTIES, NORTH CAROLINA
LETCo. Job No. CHW 5475

SECOND FIVE-YEAR INDEPENDENT CONSULTANT INSPECTION
AS REQUIRED BY
NORTH CAROLINA UTILITIES COMMISSION

JULY, 1986

BY

LAW ENGINEERING TESTING COMPANY
CHARLOTTE, NORTH CAROLINA

REPORT PREPARED BY

Fred C. Tucker

Fred C. Tucker, P. E.
Senior Geotechnical Engineer
Registered, N. C. 8160

NORTH CAROLINA PROFESSIONAL SEAL 8160 ENGINEER FREDERIC C. TUCKER

Clay E. Sams

Clay E. Sams, P. E.
Geotechnical Consultant
Registered, N. C. 4459

NORTH CAROLINA PROFESSIONAL SEAL 4459 ENGINEER CLAY E. SAMS

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 General

This report presents the results of the second independent consultant inspection of the ash basin dikes at the Cliffside Steam Station. The independent inspection is performed at five-year intervals as required by the North Carolina Utilities Commission (NCUC) for facilities operated by Duke Power Company in North Carolina and not licensed by the Federal Energy Regulatory Commission (FERC) and not covered by the North Carolina Dam Safety Law of 1967.

The previous independent inspection was performed in 1981 also by Law Engineering Testing Company. The results of that inspection were presented in a report dated October 12, 1981 (LETCo. Job No. CH 4581).

In this current report, emphasis is placed on noting the development of any new conditions or changes in old, previously reported conditions. The previously reported conditions are recounted only where there is a change or where it is of particular interest or of use in describing the overall condition of a specific project structure. Liberal use is made of photographs to minimize descriptions. The photographs are used to illustrate general conditions of project structures in overall views and specific conditions in close-up views.

1.2 Purpose and Scope

The purpose of this dike safety inspection and report is to identify, within the limitations of surficial field inspection and office review of available data, records and operating history, any actual or potential deficiencies, whether in the condition of the project works or in the quality or adequacy of project maintenance, surveillance, or methods of operation, that might endanger public safety. The objective is to recommend immediate action for public protection where necessary, further studies and analyses where required, and acceptance of the present condition of the dikes if the engineering data and inspections so justify.

A review was made of all available relevant reports on the safety of the ash basin dikes. These include reports by or for Federal or State agencies, submitted under NCUC regulations, and reports of inspections performed by Duke engineers. A detailed systematic visual inspection of the project works was performed. A relatively detailed photographic record was made of the visible conditions of the principal project works. Review was made of all available relevant data concerning the stability and operational adequacy of the project works. Based upon results of the above work, an engineering opinion is given of the general condition and adequacy of the dikes, as well as an assessment of the quality and adequacy of maintenance, surveillance, and methods of project operation for the protection of public safety.

The purpose and scope of this inspection and report are consistent with that outlined in Duke Power Company's Specification No. SSS-0502-02, "Specifications for Inspection of Facilities as Required by the North Carolina Utilities Commission" dated February 14, 1986.

1.3 Authorization

This NCUC Five-Year Independent Consultant Inspection was authorized by Messrs. S. B. Hager, Chief Engineer, and R. S. Bhatnagar, Senior Engineer, of Duke's Civil/Environmental Division, in their letter dated March 20, 1986.

2.0 PROJECT INFORMATION

2.1 Location, General Description and Relevant Historical Information

The Cliffside Steam Station is located on the Broad River approximately 55 miles west of Charlotte and about 1.5 miles south of the small town of Cliffside, North Carolina. The power plant is situated primarily on the south side of the Broad River and straddles the Cleveland/Rutherford County line. The Units 1-4 ash basin and the Suck Creek ash basin lie southeast of the Units 1-4 powerhouse in Cleveland County; the Unit 5 ash basin lies southwest of the Unit 5 powerhouse in Rutherford County. The project location is shown on Figures 1 and 2 of our 1981 report; these figures are included for reference in Appendix A of this current report.

The facilities of concern in this inspection are the earthfill dikes which impound the ash basins, and the outlets for the basins. The Suck Creek ash basin is the only basin that is currently being used for disposal of ash. The Units 1-4 ash basin and the Unit 5 ash basin have both been retired, except that part of the Units 1-4 basin area is being used as a holding pond for yard drainage from all the units. There also is a small dredge spoil pond within the Units 1-4 basin. A dredge that periodically removes sediment from the plant intake structure on the river pumps the spoil material into the dredge spoil pond. The dredge spoil pond and the yard drainage pond are interconnected with a culvert. Water that accumulates in the yard drainage pond is pumped to the Suck Creek ash basin.

The Units 1-4 ash basin dike is an L-shaped earthfill embankment with an overall length of about 1480 ft along the crest. The dike was designed to have a 15-ft wide crest at elevation 706 ft-MSL. Maximum height of the dike is about 38 ft above the outside (downstream) toe. Design drawings called for a 2.5H:1V inside (upstream) slope and a 2H:1V outside slope to elevation 682 ft, then 2.5H:1V slope below 682 ft to the toe of the slope.

The outlet for the Units 1-4 ash basin is a reinforced concrete drainage tower with bottom discharge into a 30-inch diameter corrugated metal pipe (CMP) which extends approximately 180 ft (horizontally) through the base of the embankment at a skewed section located near the east end of the dike.

The Unit 5 ash basin dikes are earthfill embankments, including a main dike, a saddle dike and an access road dike. The main dike and saddle dike are the principal embankments which formed the ash basin. The dikes were designed to have a 20-ft wide crest at elevation 767 ft-MSL. The main dike is about 1460 ft long at the crest and has a maximum height of about 97 ft above the toe of the outside (downstream) slope; the saddle dike is approximately 590 ft long at the crest and has a maximum height of about 42 ft above the toe of the outside slope (57 ft above the inside slope toe). Design drawings called for 2.5H:1V inside slopes, a 2.8H:1V outside slope at the main dike and a 2.7H:1V outside slope at the saddle dike.

The outlet for the Unit 5 ash basin is a reinforced concrete drainage tower with bottom discharge into a 60-inch diameter reinforced concrete pipe (RCP) which extends approximately 500 ft (horizontally) through the left abutment of the main dike.

The Suck Creek ash basin was formed by construction of two earthfill dikes across Suck Creek, bracketing a 5600-ft long meandering reach of the natural stream valley for ash storage. At the upstream dike, the creek was diverted through a canal to the Broad River.

The downstream dike, located just upstream of the original confluence of Suck Creek with the Broad River, is 876 ft long. The upstream dike is 890 ft long. Both dikes were designed to have 15-ft wide crests at elevation 775 ft-MSL. Maximum height of the downstream dike is about 120 ft above the toe of the outside slope; that of the upstream dike is about 60 ft above the outside slope toe and 65 ft above the inside slope toe.

The downstream dike was designed to have a final inside slope of 2.5H:1V from the crest down to a 15-ft wide berm at elevation 737 ft-MSL, 2H:1V slope below this berm to a lower, 50-ft wide berm at 675 ft-MSL; then 2H:1V slope down to prepared foundation grade. The final outside slope was designed to be 2.5H:1V with 2 berms: one 15-ft wide at elevation 725 ft-MSL and another 20 ft wide at 680 ft-MSL. The 2.5H:1V slope below the lower berm has a cover of riprap designed to be 2.5 ft thick and bedded on a 1-ft thick crushed stone layer. Beyond the toe of the outside slope there is a channel leading to the river. The banks of this channel are protected with weathered riprap.

The upstream dike was designed to have a 2.5H:1V inside slope and 2.5H:1V outside slope down to a berm at elevation 730 ft-MSL; then 2H:1V slope below the berm. The outside slope (and berm) below elevation 735 ft were designed to have a weathered riprap cover.

The outlet for the Suck Creek ash basin is a reinforced concrete drainage tower with bottom discharge into a 42-inch diameter RCP which extends approximately 700 ft (horizontally) beneath the downstream dike at its left (west) abutment.

Additional descriptions of the physical characteristics and design features of the Cliffside Station ash basin dikes are presented on p. 3 (Units 1-4 ash basin dike), pp. 10-11 (Unit 5 ash basin dikes) and pp. 16 and 17 (Suck Creek ash basin dikes) in the 1981 report. Plan and section views of the dikes are shown on Figures 3 through 8 of the 1981 report; these figures are included for reference in Appendix A of this current report.

A relatively detailed account of historical information on the design, construction, operation, instrumentation monitoring and previous inspections of the ash storage facilities up to the time of the first independent consultant inspection is presented on pp. 4-6, pp. 11-13 and pp. 17-20 of the 1981 report. Since that time no significant changes or additions affecting safety of the ash basin dikes have been made.

2.2 Size Classification

The ash basin dikes at the Cliffside Steam Station have size classifications as listed in the following table.

Structure	Maximum Height (Ft)	Size Classification: By Corps of Engineers Criteria	Size Classification: By N.C. State Criteria
Units 1-4 Dike	38	Small	Medium
Unit 5 Dikes	97	Intermediate	Large
Suck Creek Dikes	120	Large	Very Large

The maximum heights listed above dictate the size classifications.

2.3 Hazard Classification

All the Cliffside ash basin dikes are classified "low" hazard (Class 3) under the Corps' guidelines and "low" hazard (Class A) by the North Carolina criteria, due to the lack of downstream development.

As previously noted, the Units 1-4 ash basin and the Unit 5 ash basin have been retired and no longer impound any significant volume of water; they no longer serve as impoundments and thus the assigned size and hazard classifications no longer have any relevance with respect to flood hazard.

2.4 Geology and Seismicity

The Cliffside ash storage basins are located in the Inner Piedmont geologic belt, which is the westernmost of a series of northeast-trending metamorphic belts that comprise the Piedmont Physiographic Province of the southeastern United States (King, 1955). The predominant rocks in the Inner Piedmont are gneisses and schists. However, they are interspersed with granitoids and a few scattered bodies of mafic and ultramafic rocks. The peak of regional metamorphism is considered to have ended in this area in Silurian or Devonian time, some 400 to 375 million years ago (Butler, 1972). The general rock structure in this belt is characterized by irregular foliation of low dip and some broad folds transverse to the northeast regional geologic trend (King, 1955).

The local geology at the Cliffside ash storage basins consists of biotite gneiss and schist with subordinate layers of various metasedimentary rocks (Goldsmith, et al., 1982). Small masses of granitic rock are common in this part of the Inner Piedmont; the Unit 5 ash basin might be just south of such a granitic unit.

Because earthquake epicenters cannot be correlated with tectonic structures, the present practice is that earthquakes in this part of the United States are identified with the tectonic province in which they are located. The Cliffside ash storage basins are located in the southern Piedmont province (or seismotectonic region) in which the highest seismicity is Intensity VII MM. The dikes are also located in Seismic Zone 2; the Corps of Engineers' guidelines indicate that, "in general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake provided static stability conditions are satisfactory and conventional safety margins exist".

Butler, J. R. 1972 — Age of Paleozoic regional metamorphism in the Carolinas, Georgia and Tennessee southern Appalachians: Amer. Jour., Sci., v. 272, pp. 319-333.

Goldsmith, R., Milton, D. J. and Horton, J. W., Jr. 1982 — Simplified preliminary geologic map of the Charlotte 1^{o}x 2^{o}quadrangle, North Carolina and South Carolina: U.S. Geol. Survey Open File Report 82-56.

King, P. D. 1955 — An outline of the geology in the segment in Tennessee, North Carolina and South Carolina: in Geol. Soc. Amer., Guides to Southeastern Geology, pp. 332-373.

3.0 ENGINEERING AND OPERATIONAL INFORMATION

3.1 Engineering Information

A description of the available information on design of the Cliffside ash basin dikes up to the time of the last independent inspection is contained on p. 4, pp. 11-12 and pp. 17-18 of the 1981 inspection report.

In 1983 Duke Power engineers made a study of the as-built stability of the slopes of the upstream and downstream dikes of the Suck Creek ash basin based on results of shear strength testing of the in-place embankment soils. The data for the slope stability analyses were obtained by Duke by drilling six soil test borings, obtaining relatively undisturbed (Shelby) tube samples in the borings and performing laboratory triaxial shear tests. Piezometers were installed in all the borings. Recently (June, 1986) Duke re-analyzed stability of the inside slope of the Suck Creek downstream dike under rapid drawdown conditions. No other engineering analyses have been performed since the 1981 independent inspection.

3.1.1 Slope Stability:

For the dike of Units 1-4 basin, static slope stability analyses performed by Law-Barrow-Agee (Law Engineering) in 1956 indicated safety factors of about 2.5 and 2.0 for 2.5H:1V and 2H:1V slopes, respectively, under full pond conditions. Both circular arc and sliding block analyses were performed by hand. Soil design shear strength parameters were derived from triaxial shear tests on remolded samples of potential borrow soils and on undisturbed (Shelby tube) samples of the foundation soils. The remolded samples were "soaked" prior to shear testing. The triaxial shear tests consisted of encasing each test sample in a rubber membrane, placing the samples in a closed chamber (triaxial cell), subjecting the samples to different confining pressures and then axially loading the samples until failure occurred. The soil design parameters used in the stability analyses were as follows:

Material	Unit Wt.	Shear Strength Parameters (Total)
Foundation Soil	116 pcf	ϕ=18°, c=1500 psf
Embankment Soil	119 pcf	ϕ=12°, c=1200 psf

The results of slope stability analyses performed by Bechtel Corporation in 1969 indicated a safety factor of 1.53 for the 2.8H:1V outside slope of the main dike of the Unit 5 ash basin under steady state seepage conditions. The analyses were performed by computer. Analyses of the inside slope of this dike are not evident and would not now be relevant since the inside slope is almost entirely buried with ash. The soil design parameters used in the analyses were as follows:

Material	Unit Wt.	Shear Strength Parameters (Effective)
Foundation Soil	*	ϕ'=24°, c'=180 psf
Embankment Soil	*	ϕ'=33.7°, c'=0

*Unit weights used in the analyses are not apparent from the available records but probably were on the order of 110 pcf for the foundation soil and 125 pcf for the embankment soil based on available laboratory test results.

As previously mentioned, in 1983 Duke analyzed static stability of the as-built dikes which impound the Buck Creek ash basin, and recently Duke re-analyzed the downstream dike's inside slope for rapid drawdown conditions. The analyses were performed by a computer program (LANSLI) which uses a method of analyses similar to the Ordinary Method of Slices. The results for the more critical, downstream dike were as follows:

Condition	Slope	Calculated Factor of Safety (FS)
Steady State Seepage (Pond El. 772 ft-MSL)	Outside (Downstream)	>1.5
	Inside (Upstream)	1.5*
Rapid Drawdown (El. 772 to 755 ft-MSL)	Inside (Upstream)	1.76

*Factors of safety in the range of 1.35 to 1.40 were calculated for shallow (4 to 10 ft deep) potential failure arcs on the 2H:1V portion of the inside slope.

The 1983 analyses used soil design parameters as follows:

Material	Unit Wt.	SCU(1) Parameters	SCUe(2) Parameters
Foundation Soil	105 pcf	$\phi=25^\circ$, $c=0$	$\phi'=25^\circ$, $c'=0$
Embankment Soil	131 pcf	$\phi=28^\circ$, $c=800$ psf	$\phi'=34^\circ$, $c'=0$
Internal Drain	120 pcf	$\phi=30^\circ$, $c=0$	$\phi'=30^\circ$, $c'=0$

(1) SCU = Saturated Consolidated Undrained Triaxial Test (R)

(2) SCUe = Saturated Consolidated Undrained Triaxial Test Corrected for Pore Pressure ($\bar{R}$)

The existing stability analyses, as summarized above, indicate computed factors of safety which generally meet or exceed the conventional minimum safety factor criteria of 1.5 for steady state seepage conditions and 1.25 for rapid drawdown conditions (where applicable). The lower-than-minimum safety factors computed for the inside slope of the Suck Creek downstream dike under steady state conditions are for shallow potential failure arcs which would not threaten immediate failure of the dike, in our opinion.

It is noted that the soil mechanics testing and stability analyses done for the Units 1-4 basin dike were done 30 years ago when triaxial testing procedures and analytical methods of slope stability analyses were still in their formative stages. The state-of-the-art has advanced much since then. The shear strength parameters used in the 1956 stability analyses would not, in current practice, be reasonable values to use in analyses of slope stability under steady state seepage conditions. (Except for the "soaking" of the embankment soil samples prior to shearing, the conditions of testing the triaxial samples in the laboratory more closely simulated end of construction conditions.) However, since the Units 1-4 basin is retired and does not impound a significant volume of water and since the dike has shown satisfactory performance, it is our opinion that a re-evaluation of the soil shear strength parameters and re-analysis of stability of the Units 1-4 basin dike using current methods are not warranted.

3.1.2 Hydrology and Hydraulics:

Approximate analyses of hydrology and hydraulics of the ash storage basins at the Cliffside Steam Station are presented on p. 7 (Units 1-4 ash basin), pp. 13-14 (Unit 5 ash basin) and pp. 21-22 (Suck Creek ash basin) of the 1981 independent inspection report. In those analyses it was found that the retired Units 1-4 ash basin and the retired Unit 5 ash basin should be capable of safely passing or storing runoff from the 100-year, 24-hour duration storm (7.3 inches rainfall depth); it was also found that the Suck Creek ash basin should be capable of passing flood runoff from the 1/2 PMP (probable maximum precipitation) storm (18.25 inches rainfall depth in 24 hours), though the margin of freeboard may be small when the basin approaches full capacity with settled ash.

The indicated spillway design floods (SDF) for the Cliffside ash basins are as follows (assuming all are impoundments):

Facility	Spillway Design Flood (SDF) By Corps of Engineers Criteria	By N.C. State Criteria
Units 1-4 Basin	50-100 years	100 years
Unit 5 Basin	100 years - 1/2 PMF*	1/3 PMP**
Suck Creek Basin	1/2 - 1 PMF*	1/2 PMP**

*Probable Maximum Flood
**Probable Maximum Precipitation

The degree of hydrologic safety shown by the existing analyses for the Units 1-4 ash basin and the Unit 5 ash basin (i.e., both safe for 100-year storm) is adequate, in our opinion, for these retired basins which no longer serve as impoundments. The capability of the Suck Creek ash basin to pass a flood produced by 1/2 PMP is adequate according to the SDF-criteria given in the above table.

No changes or modifications have been made at the basins which would significantly change the assumptions of the existing hydrologic/hydraulic analyses; thus, no further study of hydrology or hydraulics appears warranted at this time. Pertinent hydrologic data and results of the existing analyses are summarized below for reference:

Units 1-4 Ash Basin (Retired)

100-yr, 24-hr Duration Rainfall Depth:	7.3 Inches
Drainage Area:	65± Acres
Top of Spillway Elevation (Stop-log Height):	692 ft-MSL
Top of Dike Elevation:	706 ft-MSL
General Level of Ash in Basin:	697 ft-MSL
Yard Drainage Holding Pond Water Level:	693 ft-MSL (Max.)
Surcharge Storage Between 693 and 697 ft-MSL:	Ignored
Surcharge Storage Between 697 and 706 ft-MSL:	117 Acre-ft
100% Runoff Volume (7.3 inches):	39.5 Acre-ft
Freeboard:	6 ft*

*Assumes no outflow and linear variation in surcharge storage from 0 acre-ft at elevation 697 ft-MSL to 117 acre-ft at elevation 706 ft-MSL.

Unit 5 Ash Basin (Retired)

100-yr, 24-hr Duration Rainfall Depth:	7.3 Inches
Drainage Area:	200± Acres
Top of Spillway Elevation (Max. Stop-log Height):	762 ft-MSL
Top of Dike Elevation:	767 ft-MSL
General Level of Ash in Basin:	763 to 764 ft-MSL
Surcharge Storage Between 763 and 764 ft-MSL:	28 Acre-ft
Surcharge Storage Between 764 and 767 ft-MSL:	110 Acre-ft
Total Surcharge Storage (763 to 767 ft-MSL):	138 Acre-ft
Curve No. (CN):	71
Runoff Volume (4 inches):	67 Acre-ft
Freeboard:	2 ft**

**Assumes no outflow and linear variation in surcharge storage from 0 acre-ft at 763 ft-MSL to about 28 acre-ft at elevation 764 ft-MSL, then 138 acre-ft at elevation 767 ft-MSL.

Suck Creek Ash Basin

1/2 PMP, 24-hr Duration Rainfall Depth:	18.25 Inches
Drainage Area:	258± Acres
Top of Spillway Elevation (Max. Stop-log Height):	770 ft-MSL
Top of Dike Elevation:	775 ft-MSL
General Level of Ash in Basin (at Retirement):	772 ft-MSL
Surcharge Storage Between 772 and 775 ft-MSL:	281 Acre-ft
Time of Concentration:	0.3 Hr.
Curve Number (CN):	80
Peak Inflow (1/2 PMP = 18.25 inches):	922 cfs
Runoff Volume (15.7 inches):	337.5 Acre-ft
Peak Outflow:	237 cfs
Peak Pond Elevation:	773.3 ft-MSL
Freeboard:	1.7 ft***

***Based on routing of a hydrograph produced by 24-hr duration storm. Routing of a hydrograph produced by 6-hr duration storm yields 1.3 ft of freeboard. Conditions near retirement of the basin were assumed in the analysis.

3.2 Operations Related to Project Safety

Operation of the Cliffside ash basins is described on pp. 6, 13 and 21 of the 1981 independent inspection report. No major additions or modifications to the ash storage facilities are anticipated by Duke at this time. Safety related operations are outlined below.

Safety related operations at the subject facilities involve routine inspections and maintenance as required. Inspections are carried out by Duke personnel and by outside consultants.

Plant personnel perform routine inspections of the subject facilities. Duke Power design engineers make annual inspections and prepare written reports documenting their observations. At five-year intervals, independent inspections by outside consultants are performed per NCUC regulations; these inspections are also documented by written reports.

4.0 FIELD INSPECTION OBSERVATIONS

The field inspection was done on April 23, 1986 by Mr. Fred C. Tucker, P. E. of Law Engineering in company with Mr. Tony Mathis from Duke's Design Engineering Department, Mr. Larry Harper with Fossil Operations and Mr. Dave Olney from the plant. Weather conditions during inspection were clear and cool to mild. Water level in the Suck Creek ash basin at the time of inspection appeared to be near the latest available recorded level (March 3, 1986) of 752.1 ft-MSL which is 17.9 ft below the maximum stop-log elevation. The only water contained in the old Units 1-4 ash basin is yard drainage and water from dredging operations; the water level was observed to be below the elevation (692 ft-MSL) of the stop logs at the old drainage tower. The retired Unit 5 ash basin contains no water except for a small pond located at the upper (south) end of the basin. Conditions observed are presented below. Photographs referenced below are contained in Appendix B.

4.1 Units 1-4 Retired Ash Basin Dike and Outlet Works

The Units 1-4 retired ash basin dike is overgrown with trees and other vegetation as described in the last independent inspection. The crest, shown in Photo 4-1, was observed to be essentially as it was in 1981; trees overhang the crest and there are ruts at some locations in the surface of the crest. No obvious tension cracks or major depressions were observed in the crest.

The inside (upstream) slope of the dike is almost completely buried with ash; only the upper part of the slope above ash level is visible. The upstream slope next to the dredge spoil area was observed to be covered with sand as shown in Photo 4-2. Other portions of the upstream slope were observed to be covered with weeds, briars and a few small trees. No signs of slumping or shear failure were observed on this slope. Water levels in the yard drainage holding pond and dredge spoil area were relatively low at the time of inspection as shown in Photo 4-3.

A typical view of the wooded outside (downstream) slope of the Units 1-4 ash basin dike is shown in Photo 4-4, and the cleared inspection trail located along the toe of this slope is shown in Photo 4-5. No seepage outcrops were seen on the slope above the toe, and no obvious signs of slope failure or active erosion were seen on the slope, though inspection was somewhat hampered by the vegetation.

Conditions along the bank of the river beyond the toe of the dike appeared much as they did in 1981. Seepage still occurs at a number of locations along the base of the bank next to the river. No soil particles appeared to be carried by the seepage. The yellow colored seepage, shown in Photo 4-6, appeared as it did in 1981. Several areas of past scour of the river bank were observed; one of these is shown in Photo 4-7.

The visible part of the drainage tower is shown in Photo 4-8, and the outlet end of the 30-inch diameter CMP outlet is shown in Photo 4-9. These structures still appeared to be in fair condition. The steel frame on top of the drainage tower is rusty. A small trickle of water was observed to still flow from the end of the outlet pipe. No dropouts or sinkholes were observed along the pipe alignment.

4.2 Unit 5 Retired Ash Basin Dikes and Outlet Works

The crest of the Unit 5 retired ash basin dike was observed to be in good condition with no tension cracks or major depressions. The uppermost several feet of the inside (upstream) slope above ash level was observed to be covered with the previous year's growth of broom sedge and weeds; no problems were seen on this slope.

An overall view of the outside (downstream) slope of the Unit 5 ash basin main dike is shown in Photo 4-10. This slope was observed to be covered with the previous year's growth of grass, weeds, and broom sedge and a new growth of briars in many areas. No slumps, slides or significant erosion were seen on this slope. No seepage or wet areas were observed on the slope above the toe. The areas of clear seepage and the swampy area noted at the downstream toe of the main dike in the 1981 inspection were observed to be essentially unchanged. The swampy area located next to the riprapped toe below the right (east) abutment is shown in Photo 4-11. Bushes and small trees continue to grow in the riprap.

Water was observed to still pond in the drainage ditch located beyond the toe of the saddle dike. The source of water is believed to be seepage from natural ground below the downstream right abutment of the saddle dike. There appeared to be no transport of soil particles with the gradual seepage. The downstream slope of the saddle dike was observed to be grassed and free of seepage or wet areas. No slumps, slides or other evidence of shear failure were observed on this slope. One eroded hole, shown in Photo 4-12, approximately 18 inches deep was noted on the right central portion of the saddle dike downstream slope.

The visible part of the Unit 5 retired ash basin drainage tower is shown in Photo 4-13; the structure was observed to be in good condition. The outlet end of the 60-inch diameter RCP outlet is shown in Photo 4-14. There appeared to be some spalling along the invert of the pipe, but otherwise the pipe was in good visual condition.

4.3 Suck Creek Ash Basin Dike and Outlet Works

4.3.1 Downstream Dike:

The crest of the downstream dike of the Suck Creek ash basin was observed to be in good condition with no visible tension cracks, major depressions, sags or other signs of shear failure or excessive settlement; a view of the crest is shown in Photo 4-15.

The inside slope of the downstream dike was observed to be in good condition with a well maintained grass cover as shown in Photo 4-16. There were no signs of shear failure or major erosion on this slope. The riprapped-lined intercept ditches at the abutment contacts were in good visual condition.

The outside slope of the downstream dike was observed to be in generally good condition. A view of this slope above the upper berm is shown in Photo 4-17. A few minor eroded areas which apparently occurred before the grassing became well established were observed; one of these is shown in Photo 4-18. The grassing was observed to be relatively sparse in some areas, particularly on the slope just above the upper berm which is shown in Photo 4-19. The berm had recently been graded at the right (east) end to improve drainage of surface runoff from it and therefore had no grass cover at the time of inspection. A small slump, shown in Photo 4-20, was observed in the embankment slope just below the upper berm near the left abutment. A similar slump nearby in the left abutment had been repaired previously; the riprap covering the repaired slump area is shown in Photo 4-21. No seepage or wet areas were observed on the outside slope, and no signs of major slope failure or significant erosion were seen on this slope. Large pieces of weathered rock were observed to have fallen from the rock ledge located at the left abutment contact with the lower part of the outer slope. Some of this rock has fallen into and partially blocked the riprap-lined ditch located at the left abutment contact. The riprap-lined ditches along both abutment contacts were observed to be in generally good condition except for some weed growth in the ditches.

The riprap-lined channel leading from the toe of the downstream dike to the river is shown in Photo 4-22, and the toe of the dike is shown in Photo 4-23. No water was observed flowing from the toe of the dike into the channel, as was observed in the 1981 inspection, though the channel bottom next to the toe was damp and overgrown with cattails and other vegetation. Farther down the channel, near its end close to the river, a flow of clear seepage was observed emerging from under the riprap at the base of the left bank of the channel, as shown in Photo 4-24.

4.3.2 Upstream Dike:

Views of the crest, inside slope and outside slope of the upstream dike of the Suck Creek ash basin are shown in Photos 4-25, 4-26 and 4-27, respectively. Overall, this dike was observed to be in good condition. The grassing on the slopes was observed to be sparse in some locations as shown in the photos, but no significant erosion was noted. No tension cracks or major depressions were seen on the crest and no major depressions were seen on the crest and no slumps, slides or other signs of shear failure were seen on the slopes. The riprap-lined abutment contact ditches were observed to be in good condition and unobstructed. The riprap at the toe of the outside slope of the dike was observed to be covered with weeds. The relatively flat area beyond the toe was observed to be swampy as shown in Photo 4-28, but there was no evidence of boils or fast flowing seeps carrying soil particles.

4.3.3 Outlet Works

The visible part of the drainage tower is shown in Photo 4-29, and the outlet end of the 42-inch diameter reinforced concrete bottom discharge pipe is shown in Photo 4-30. These structures were observed to be in good condition. Discharge from the pipe was clear, and no dropouts or sinkholes were observed in the soils over the buried outlet pipe. No seepage was observed around the outside of the pipe at the outlet end.

5.0 PREVIOUS INSPECTIONS AND PERTINENT REPORTS

As previously mentioned, Duke Power design engineers make annual inspections which are documented. The annual inspection reports for the past 4 years (1982, 1983, 1984 and 1985) were reviewed. None of these reports indicated any serious conditions which would immediately jeopardize the safety of the Cliffside ash basin dikes.

6.0 MONITORING INFORMATION

In August, 1983 six piezometers (P1 through P6) were installed in the downstream dike of the Suck Creek ash basin: three (P1 through P3) were installed along the outside edge of the crest at elevation 775 ft-MSL and three (P4 through P6) were installed along the outside edge of the upper berm at elevation 725 ft-MSL. The piezometers on the crest were installed to depths of about 50 ft, and those on the upper berm were installed to depths ranging from 38.4 ft to 41.4 ft; each was sealed 7 ft above the bottom of the 1/2 inch PVC piezometer tube which was slotted in the bottom 5 feet. Water level readings in the piezometers have been taken generally on a monthly basis since April, 1984. The water level in the Suck Creek ash basin has also been recorded on a monthly basis along with the piezometer readings.

No settlement monuments or other instrumentation besides the piezometers are monitored at the Cliffside ash basin dikes. However, there are plans to install two additional piezometers (P7 and P8) in the outside slope of the Suck Creek downstream dike: one is to be located on the slope at elevation 743 ft-MSL, between the crest and upper berm, and the other is to be located at elevation 700 ft-MSL, between the upper and lower berms.

Approximate locations of the piezometers are shown on Figure 9 in Appendix A. Furnished time versus reading plots of the monitoring data are included in Appendix C; the monitoring record shown by these plots extends to March, 1986. The individual readings of the piezometers and of the water levels in the Suck Creek ash basin are also included in Appendix C for reference. Comparison of the recorded piezometer levels with the design phreatic line are shown on the cross section in Figure 9 in Appendix A.

The monitoring record indicates that the water level in the Suck Creek ash basin fluctuated very little during the period of available record (April, 1984 through March, 1986); the recorded water level varied from 752 ft-MSL to 752.6 ft-MSL or 18 to 17.4 ft below the maximum stop-log elevation of 770 ft-MSL.

Large fluctuations in water level readings were recorded in the piezometers on the crest (P1 through P3). The differences between highest and lowest readings during the period of available record were approximately 12.4 ft, 10 ft and 14.2 ft at piezometers P1, P2 and P3, respectively. There is no apparent pattern to the fluctuations and no reason for them, except that there may have been errors in taking or recording the measurements. After June, 1985, fewer large fluctuations in water level in these piezometers were recorded. No long term upward trend in the water levels in the crest piezometers is indicated by the monitoring data. In fact, the water levels recorded after June, 1985 typically were well below the initial readings and were below the elevations of the seals in the piezometers. These piezometers have generally functioned like observation wells, except when the higher water levels were recorded. The highest recorded water levels below the crest were well below the design phreatic line, by more than 23 ft, but the water level in the basin has also been well below design (full pond) level.

The three piezometers (P4 through P6) on the upper berm have generally shown water level fluctuations less than 2 ft with no apparent upward trend in water level. A large drop in water level of about 6 ft in P5, recorded in July, 1984, apparently was an error since the recorded water level was almost 2.8 ft below the indicated bottom elevation of the piezometer tube. No water has been present in P4 since January, 1985; therefore, no time versus water elevation plot is included in Appendix C for this piezometer after that date. The recorded water levels in piezometers P4 through P6 are below the elevations of the seals; thus, these piezometers have been functioning like observation wells. All the recorded levels in P5 are above the design phreatic line (see Figure 9 in Appendix A).

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Our inspection found no obvious signs of imminent instability or serious inadequacy of any of the dikes and outlet structures at the Cliffside Steam Station that would require emergency remedial action.

The conditions observed at the Units 1-4 ash basin dike and at the Unit 5 ash basin dikes are essentially the same as those observed in the 1981 independent inspection except that the Unit 5 ash basin main dike is becoming overgrown with weeds, briars and other natural vegetation. Since the Unit 5 basin is retired, as is the Units 1-4 basin, the natural vegetation may be allowed to grow; however, it would be desirable to maintain an inspection trail along the base of the outside slope of the main dike at the Unit 5 basin, similar to that at the Units 1-4 basin dike.

The clear seepage and wet areas observed at the toes of the outside slopes of the main dike and saddle dike at the Unit 5 basin appeared generally the same as observed in the 1981 inspection. The eroded hole noted in the outside slope of the saddle dike does not threaten stability of that dike but should be filled-in and regrassed. The small pond that remains at the southern end of the Unit 5 ash basin does not have an impact on the hydrologic safety of the dikes.

Both the upstream and downstream dikes at the Suck Creek ash basin are in generally good visual condition. The grass on these dikes is better established than in 1981, but there are still some areas of sparse growth and minor erosion.

The small slump noted on the outside slope near the left abutment of the downstream dike is shallow seated and does not threaten stability of the dike; however, it should be repaired as part of routine maintenance to prevent further deterioration of the area by erosion and sloughing. The clear seepage emerging from the left bank of the drainage channel below the toe of the downstream dike probably comes from the left abutment; it does not threaten stability of the dike as long as it remains clear flowing. The wet area observed just beyond the riprapped toe of the outside slope of the upstream dike probably is due to poor drainage from the flat toe area of seepage emerging from the internal drainage system.

In our opinion, the existing hydrologic analyses, as summarized in Section 3.1.2, give an adequate indication of the hydrologic capabilities of the ash basins. The analyses indicate that the Units 1-4 ash basin and the Unit 5 ash basin have the capability of containing or passing runoff from the 100-year storm without overtopping. This degree of hydrologic safety is adequate, in our opinion, for the retired basins which no longer serve as impoundments. The degree of hydrologic safety of the Suck Creek ash basin meets the criteria established by the Corps of Engineers and the N.C. Dam Safety regulations. No conditions were observed that would have a potentially serious impact on the assumptions used in the hydrologic analyses. No further study of the safety of the dikes with respect to flood hazard appears warranted at this time.

The existing static slope stability analyses of the ash basin dikes at Cliffside indicate computed factors of safety for deep seated potential failure arcs that meet or exceed conventional minimum safety factor criteria, though some lower-than-minimum factors of safety are indicated for shallow (less than 10 ft) potential failure arcs on the inside slope of the Suck Creek downstream dike.

The soil design parameters used in the stability analyses of the Unit 5 basin dikes and the Suck Creek basin dikes appear to be reasonable. The procedures and soil parameters used in the 30-year old analyses of the Unit 1-4 basin dike are outdated. However, because this dike has shown satisfactory performance and no longer impounds a significant volume of water, no re-analyses of its structural stability is warranted, in our opinion. Likewise, no further study of structural stability of the Unit 5 basin dike appears warranted at this time because the existing analyses appear adequate and show computed factors of safety which exceed conventional minimum safety factor criteria. At the Suck Creek basin, however, it may be advisable to re-analyze the outside slope of the downstream dike under steady state condition, depending on what results are indicated by future monitoring of the new piezometers that are to be installed on the outside slope of this dike.

Methods of maintenance and surveillance, as they relate to overall project safety, appear to be adequate. Maintenance should continue as needed to keep a good stand of erosion resistant grass on the slopes of the Suck Creek dikes and to keep the riprap-lined channel and ditches free of vegetation and other obstructions such as the rocks that have fallen from the weathered rock ledge into the left abutment contact ditch next to the outside slope of the Suck Creek downstream dike.

The piezometer monitoring data show large fluctuations in water levels in piezometers located on the crest of the Suck Creek downstream dike during the first 15 months of the 25-month monitoring record, but no alarming upward trend is indicated. The water levels in piezometer P5 located on the upper berm of the downstream dike have been above the design phreatic line. Installation of the two planned additional piezometers, which we advise be installed as observation wells, should help provide a better indication of the location of the phreatic line in the downstream dike, though there would still be some uncertainty about its location under the lower berm; another observation well, located on the lower berm, would help remove this uncertainty.

7.2 Recommendations

1) No further study of hydrologic safety is recommended at this time.

2) It is recommended that the two planned additional piezometers (P7 and P8 on Figure 9) at the Suck Creek downstream dike be installed as observation wells, rather than sealed piezometers. (They should of course be sealed against surface infiltration at the top.) It is recommended that a third, additional observation well be installed on the outside edge of the lower berm (El. 680 ft-MSL) of the downstream dike (P9 on Figure 9). It is recommended that P8 and P9 be installed down to the top fine filter layer of the internal drainage blanket. Observation well P7 should be installed no deeper than about 15 ft below the design phreatic line.

3) Re-analyses of the outside slope of the Suck Creek downstream dike under steady state seepage conditions should also be performed if monitoring

of the existing piezometers and the new observation wells to be installed show the phreatic line to be substantially above the design phreatic line (above the internal drainage blanket in the downstream part of the dike).

4) Quantitative monitoring of the Suck Creek basin water level and the piezometer water levels should continue on a monthly basis. Water level measurements in the new observation wells to be installed should also be taken monthly.

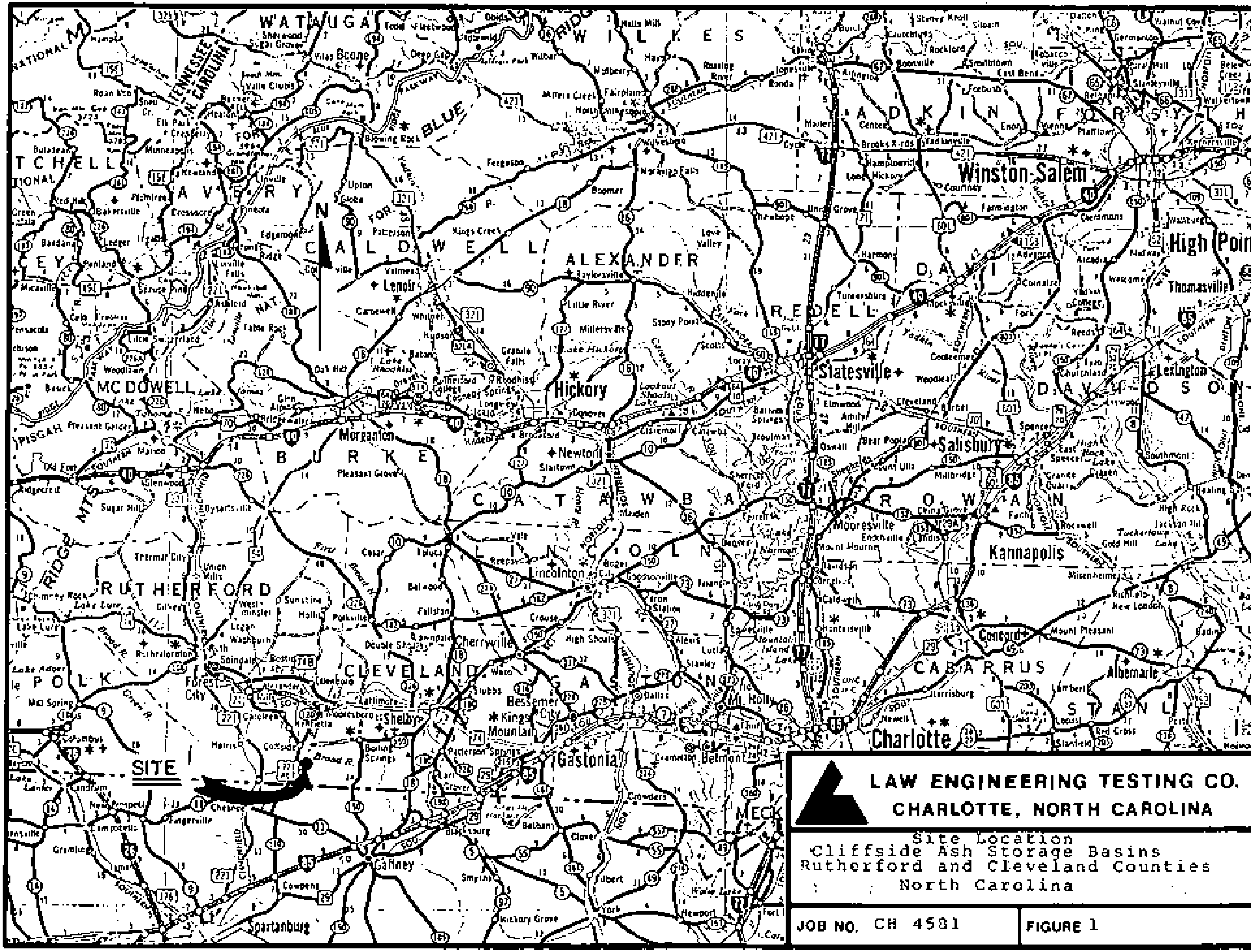
5) It is recommended that the retired Units 1-4 basin dike and the Unit 5 basin dikes be inspected during the annual inspections performed by Duke engineers; they also should be inspected by plant personnel after unusually heavy rainfalls, or during high river stages at the Units 1-4 dike. It is recommended that inspection trails be cleared at least once a year, just prior to the annual inspections, along the toes of the outside slopes of the retired dikes to facilitate the inspections.

6) Minor repairs should be made at the small slump on the outside slope near the left abutment of the Suck Creek downstream dike and at the eroded hole on the outside slope of the Unit 5 saddle dike. Other maintenance items are noted in the previous Section 7.1

APPENDIX A

Figures From 1981 Report:

New Figure:



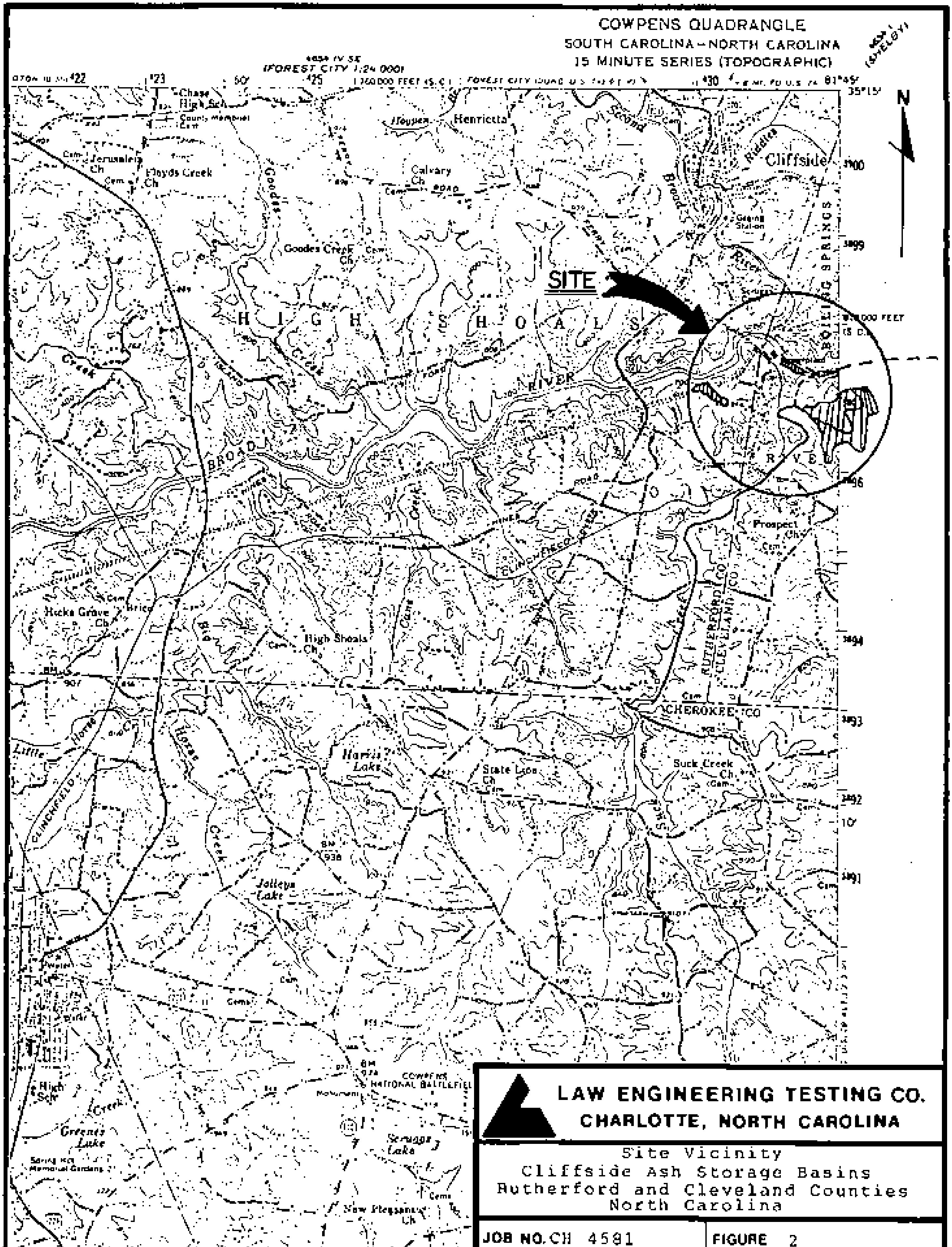
LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Site Location
Cliffside Ash Storage Basins
Rutherford and Cleveland Counties
North Carolina

JOB NO. CH 4581	FIGURE 1

Ref: Official North Carolina Road Map for 1976-1977

.Reissued under Job no. CHW5475 (June 1986)
Scale: 1" = 13 Mile (Approx.)



LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

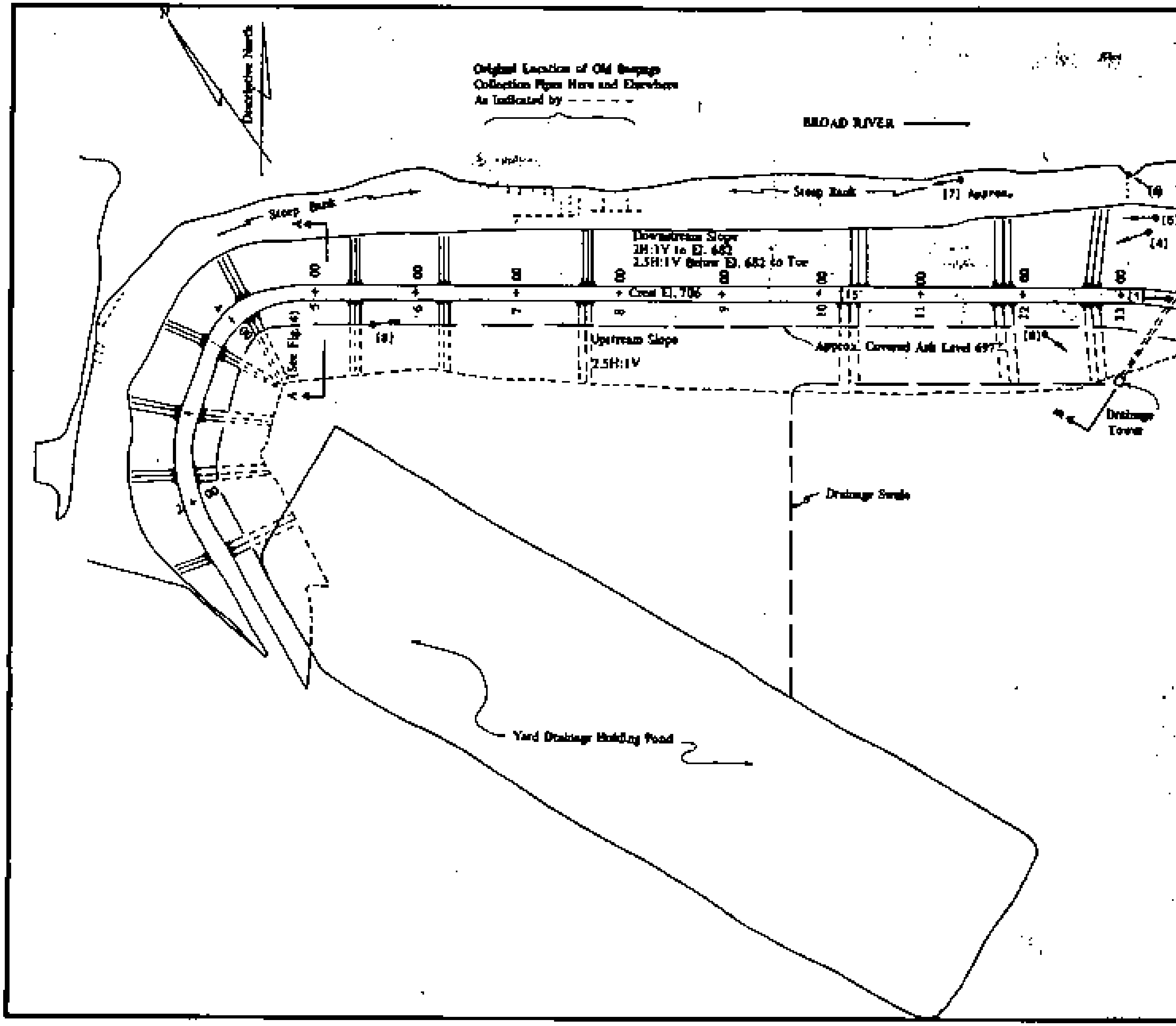
Site Vicinity
Cliffside Ash Storage Basins
Rutherford and Cleveland Counties
North Carolina

JOB NO. CH 4581	FIGURE 2

Ref: USGS Cowpens, S. C.-N.C. Quadrangle (1959)

Scale: 1" = .99 Mile (Approx.)

Reissued under Job # CHW5475 (June 1986)



INDEX TO PHOTOGRAPHS
(1986 Photos)

[1] Photo 4-1
[2] Photo 4-2
[3] Photo 4-3 (Off Site View)
[4] Photo 4-4
[5] Photo 4-5
[6] Photo 4-6
[7] Photo 4-7
[8] Photo 4-8
[9] Photo 4-9

NOTE: Arrows (←) Show Approximate Direction of View of Photographs

REF: Duke Power Company Drawing Nos. C-2004 Through C-2006 (Latest Revision Dated 6/30/77) & C-2001 (Latest Revision Dated 6/10/58)

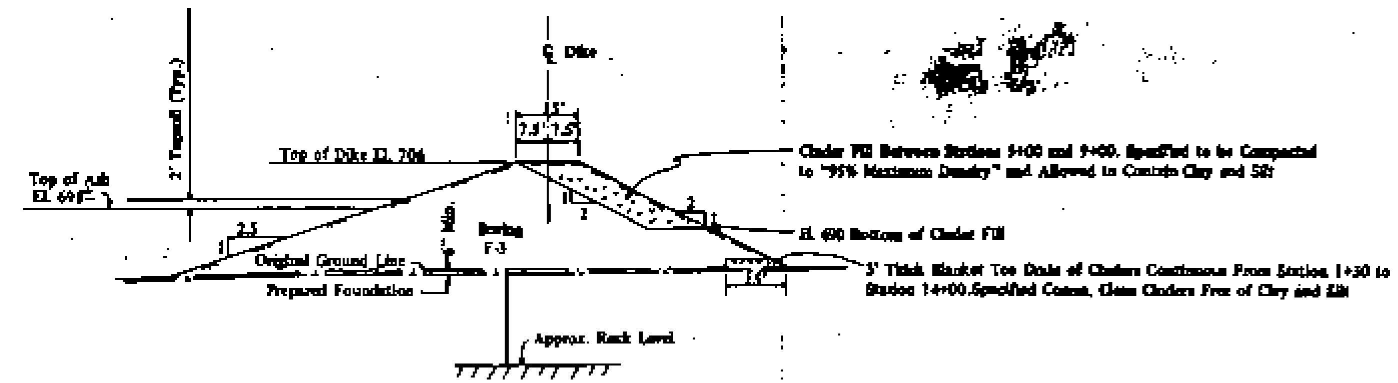
Approximate Scale, Ft.
0 50 100 200

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Plan of Units 1-4 Old Dike
Cliffside Units 1-4 Old Ash Storage Basin
Cleveland County, North Carolina

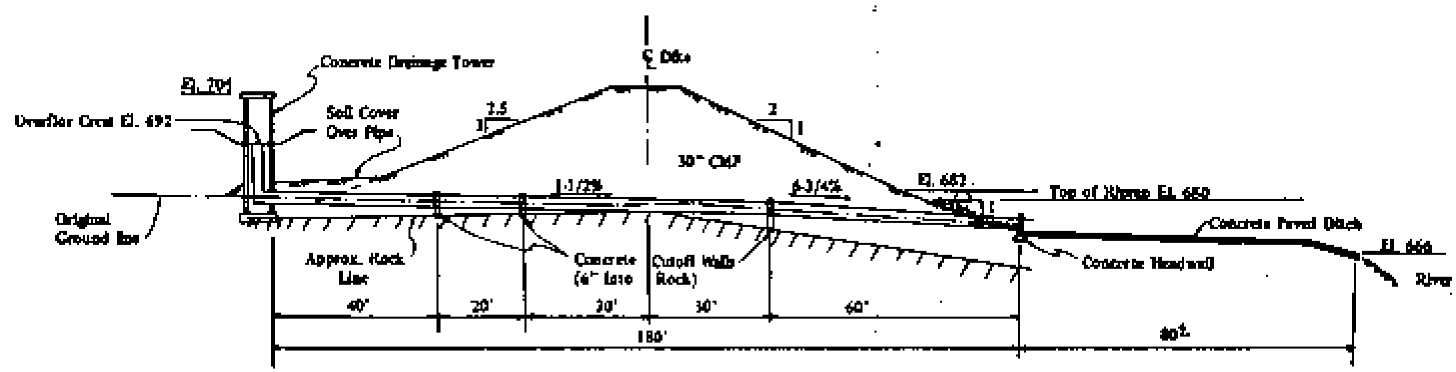
JOB NO. CH 4593 | FIGURE 1

Released under Job # CHY 5475 (June 1986)



SECTION A-A

SCALE: 1" = 30'



SECTION B-B

SCALE: 1" = 30'

NOTE: See Fig. 3 For Location of Sections

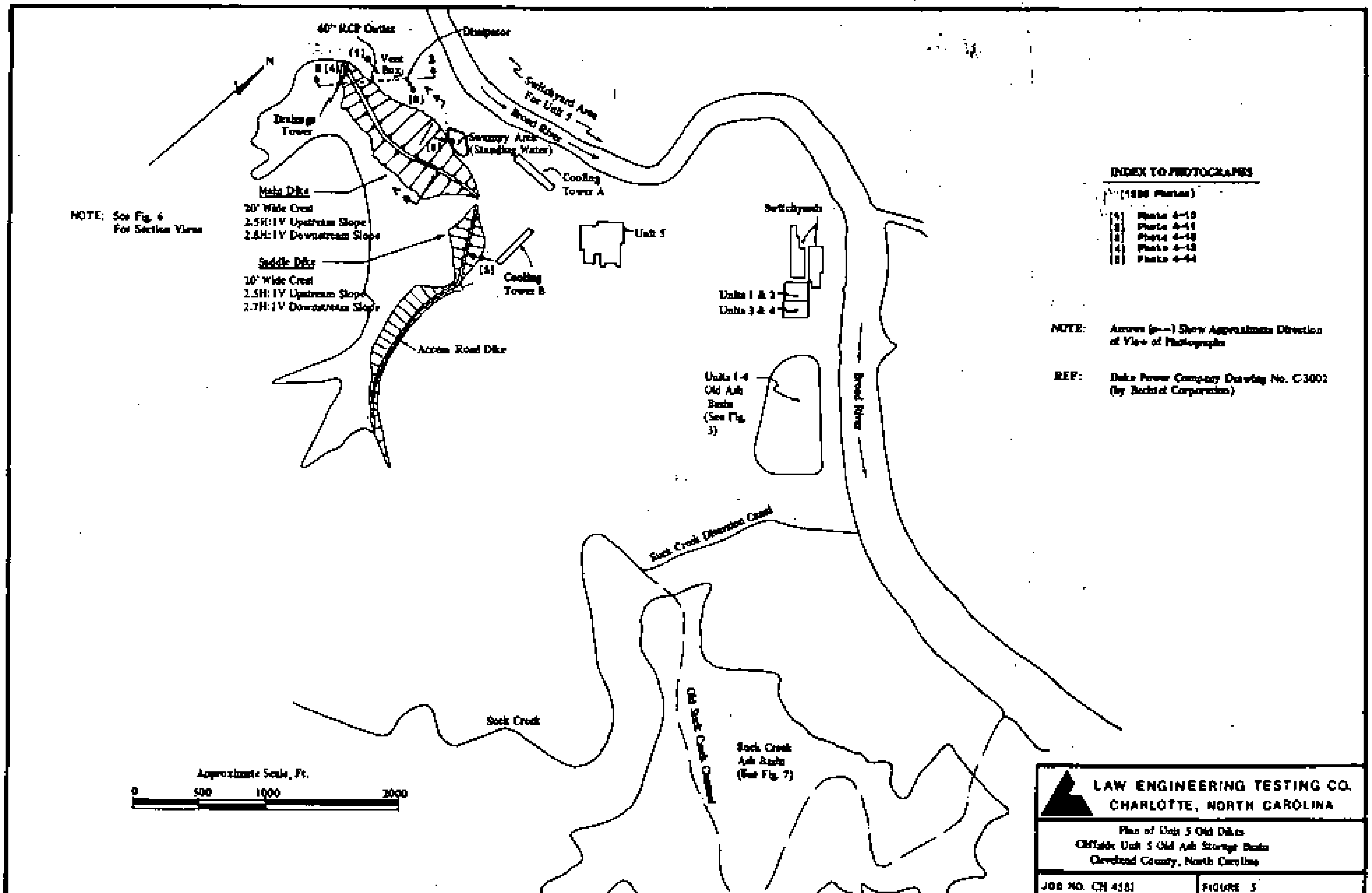
REF: Duke Power Company Drawing No. C-2004 (Latest Revision Dated 6-30-77)

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Sections Through Units 1-4 Old Dike and Basin Outlet
Cliffside Units 1-4 Old Ash Storage Basin
Cleveland County, North Carolina

JOB NO. CH 4581	FIGURE 4

Released under Job # CHM 5475 (June 1986)

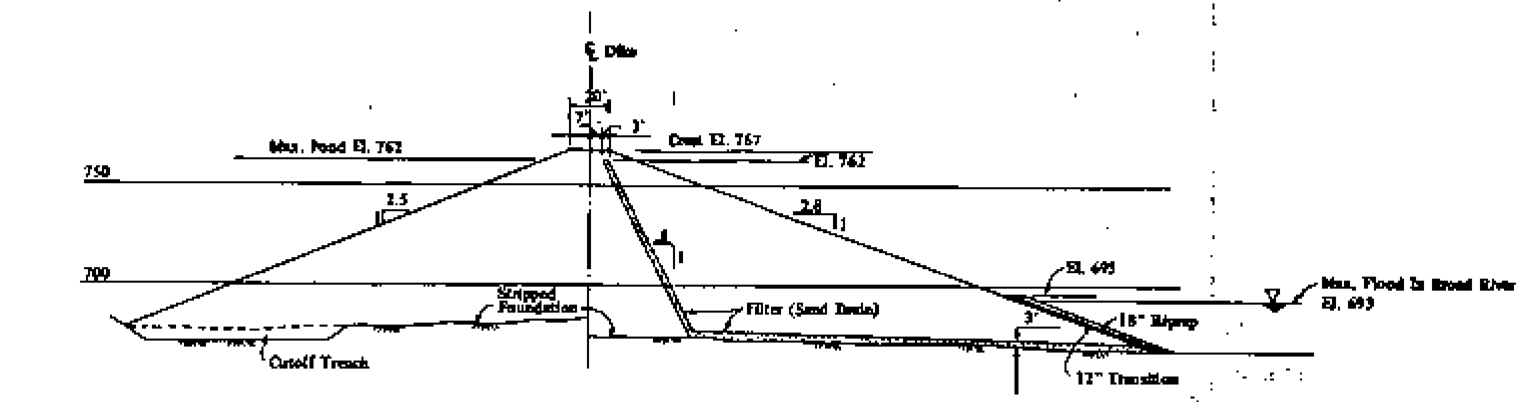


LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

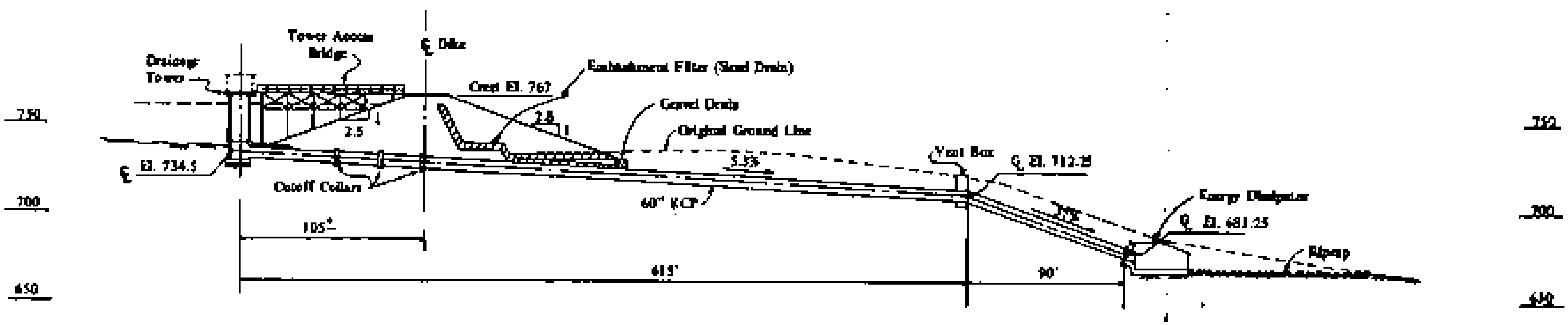
Plan of Unit 5 Old Dikes
Cliffside Unit 5 Old Ash Storage Basin
Cleveland County, North Carolina

JOB NO. CH 4581 | FIGURE 5

Reissued under Job # CHW 5475 (June 1986)



SECTION A-A



SECTION B-B

NOTE: See Fig. 5 for Location of Sections

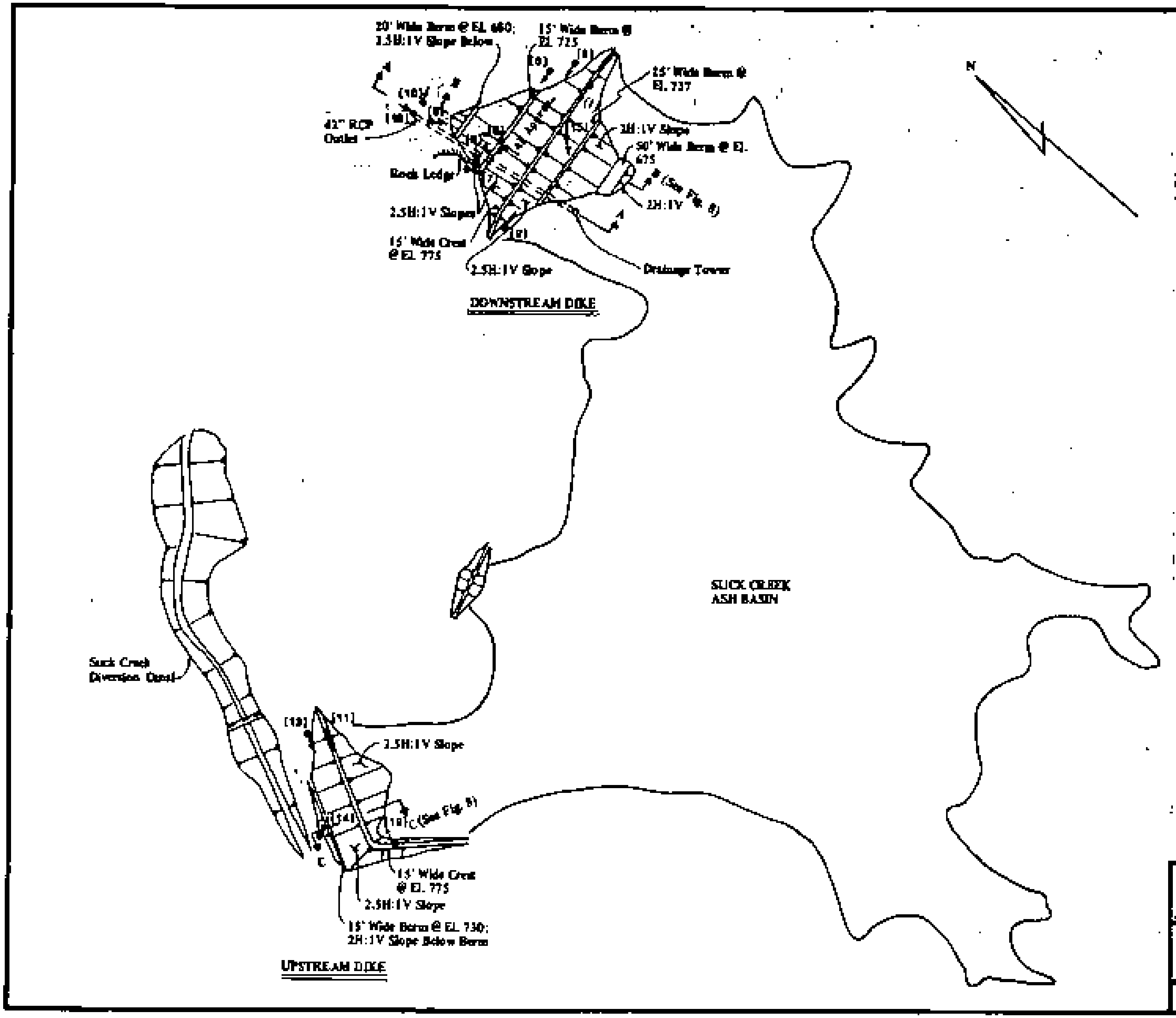
REF: Duke Power Drawing Nos. C-3037 (Latest Revision Dated 7-24-77) and C-3039 (Latest Revision Dated 6-5-70). (Both Drawings by Bechtel Corporation)

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Sections Through Unit 5 Old Main Dike and Basin Outlet
Cliffside Unit 5 Old Ash Storage Basin
Cleveland County, North Carolina

JOB NO. CH 4581 | FIGURE 6

Released under Job # CHW 3475 (June 1986)



INDEX TO PHOTOGRAPHS

(1980 Photos)

- [1] Photo 4-1[illegible]
- [2] Photo 4-[illegible]
- [3] Photo 4-47
- [4] Photo 4-1[illegible]
- [5] Photo 4-1[illegible]
- [6] Photo 4-[illegible]
- [7] Photo 4-[illegible]
- [8] Photo 4-[illegible]
- [9] Photo 4-[illegible]
- [10] Photo 4-[illegible]
- [11] Photo 4-[illegible]
- [12] Photo 4-[illegible]
- [13] Photo 4-[illegible]
- [14] Photo 4-[illegible]
- [15] Photo 4-[illegible]
- [16] Photo 4-[illegible]

NOTE: Arrows (←) Show Approximate Direction of View of Photographs

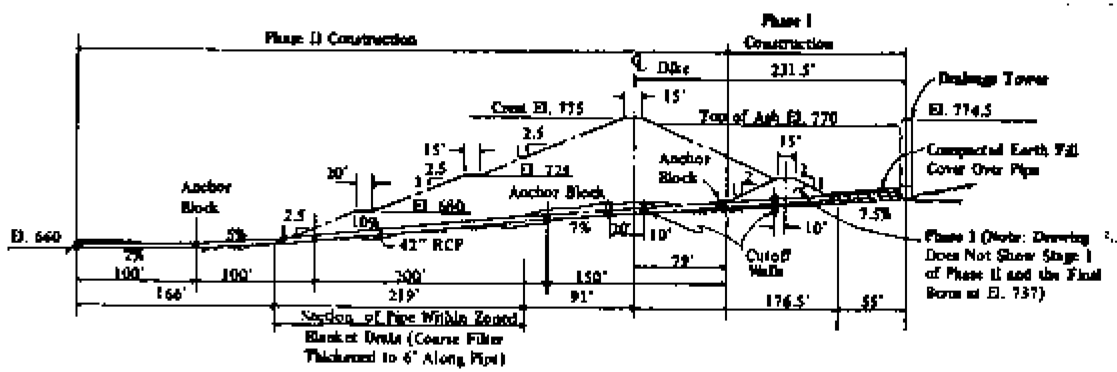
REF: Duke Power Company Drawing No. C-2015 (Latest Revision Dated 4-17-81)

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Plan of Suck Creek Dikes
Cliffside Units 1-5 New Ash Storage Basin
Cleveland County, North Carolina

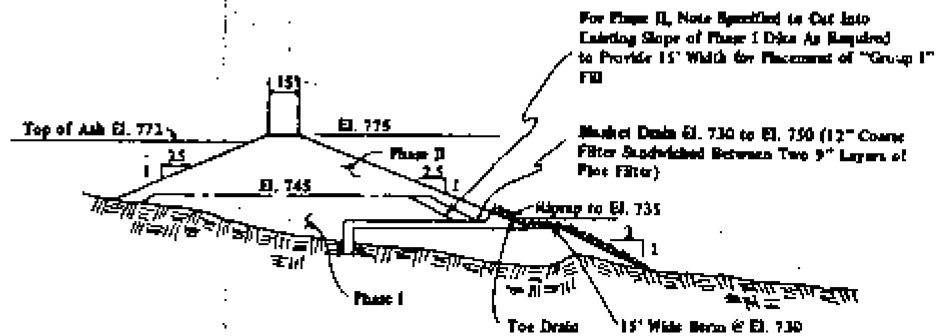
JOB NO. CH 4583	FIGURE 7

Released under Job # CHM 5475 (June 1986)



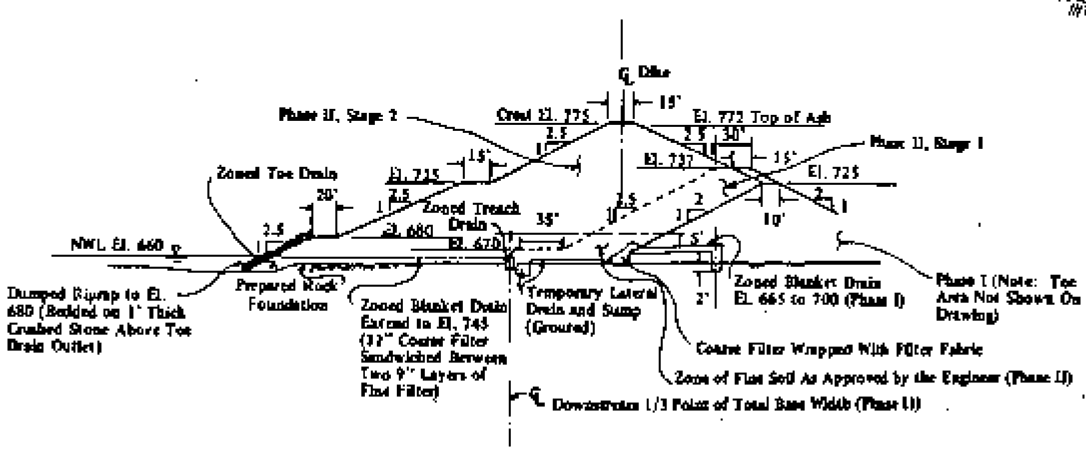
SECTION A-A

DOWNSTREAM DIKE AND OUTLET



SECTION C-C

UPSTREAM DIKE



SECTION B-B

DOWNSTREAM DIKE

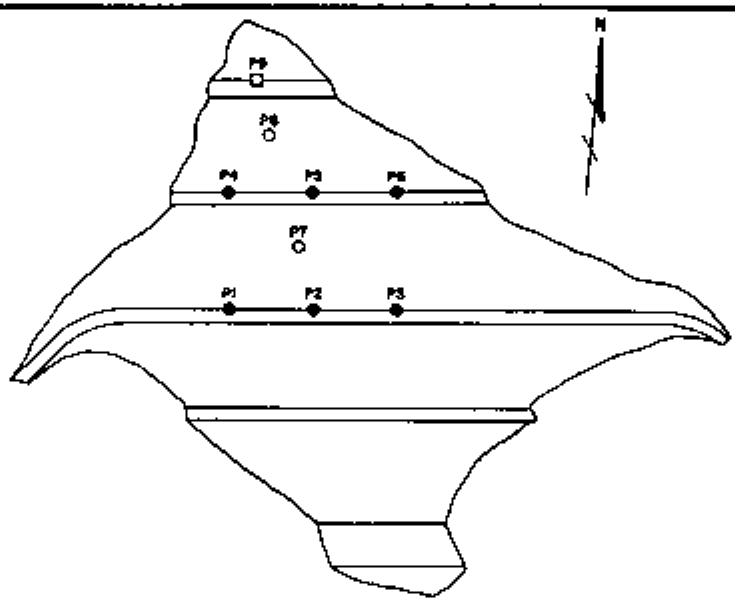
NOTE: See Fig. 7 for Location of Sections

REF: Duke Power Company Drawing Nos. C-2015A and C-2015B (Both With Latest Revisions Dated 1-31-81)

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Sections Through Suck Creek Dikes and Basin Outlet
Cliffside Units 1-5 New Ash Storage Basin
Cleveland County, North Carolina

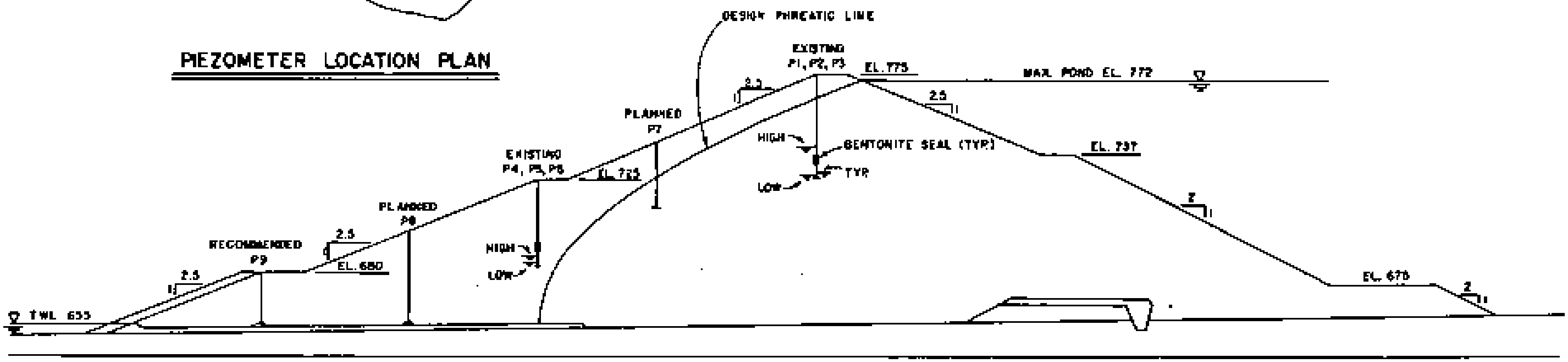
JOB NO. CH 4581	FIGURE 8



PIEZOMETER LOCATION PLAN

LEGEND

- ● EXISTING PIEZOMETER
- ○ PLANNED PIEZOMETER (RECOMMENDED OBSERVATION WELL)
- □ RECOMMENDED OBSERVATION WELL
- ▽ WATER LEVEL IN PIEZOMETER



MAXIMUM HEIGHT SECTION

LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

SUCK CREEK DOWNSTREAM DIKE INSTRUMENTATION
CLEVELAND COUNTY, NORTH CAROLINA

JOB NO. CHW 5473 | FIGURE 9

BRUNING 40-21 53592

APPENDIX B

PHOTOGRAPHS

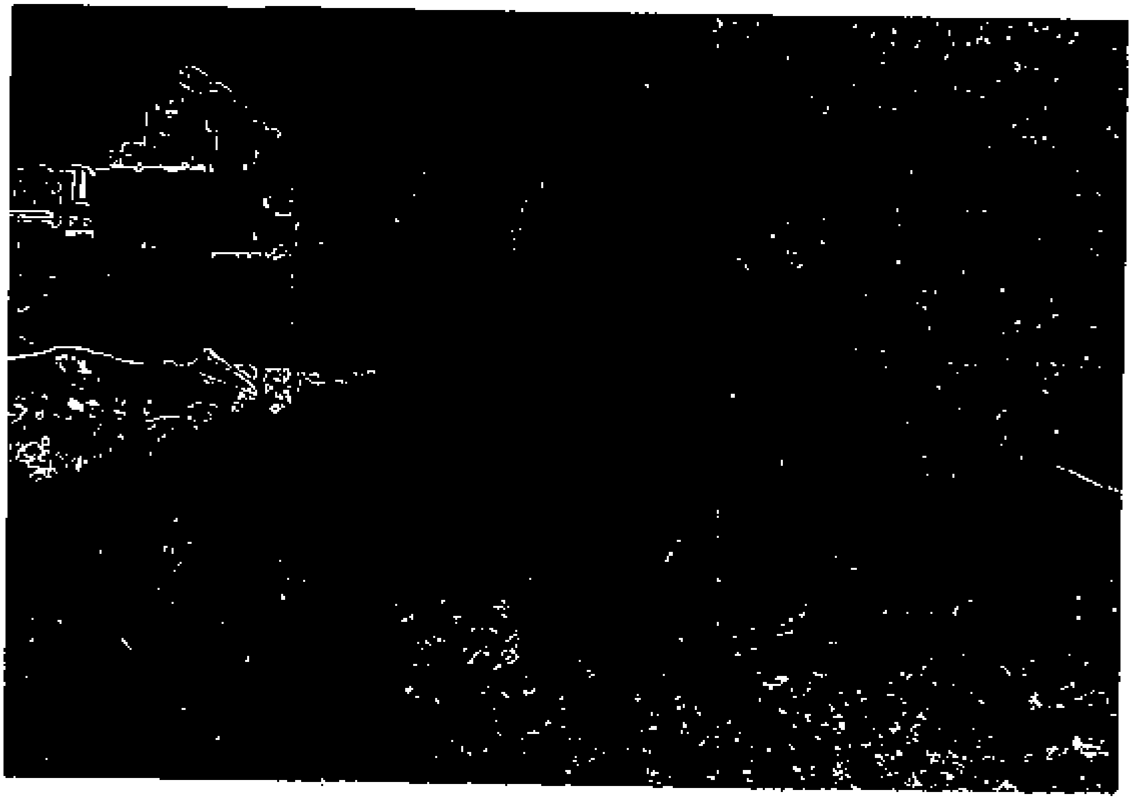


PHOTO 4-1 Crest of Units 1-4 Old Ash Basin Dike (E to W View)

PHOTO 4-2 Inside (Upstream) Slope of Units 1-4 Old Ash Basin Dike (W to E View)

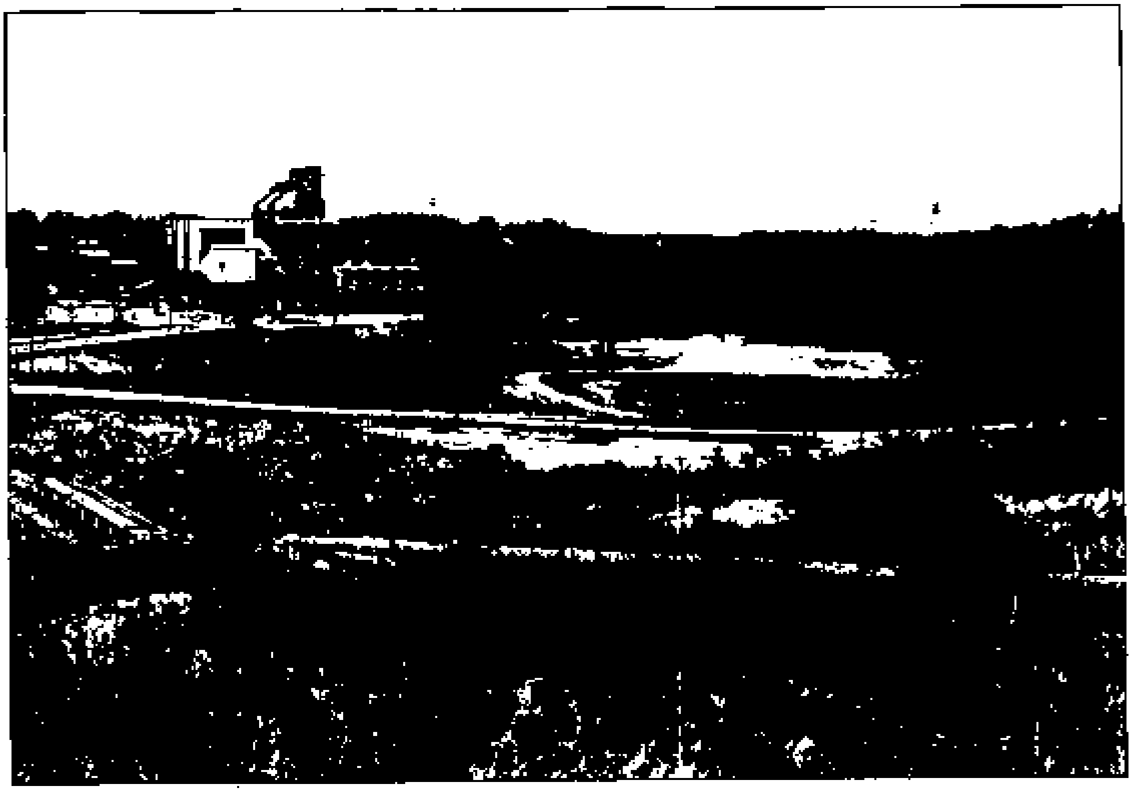


PHOTO 4-3 Yard Drainage Holding Pond and Dredge Spoil Pond in Units 1-4 Old Ash Basin Area

PHOTO 4-4 Wooded Outside (Downstream) Slope of Units 1-4 Old Ash Basin Dike

PHOTO 4-5 Trail Along Toe of Outside Slope of Units 1-4 Old Ash Basin Dike (E to W View, Slope to Left)

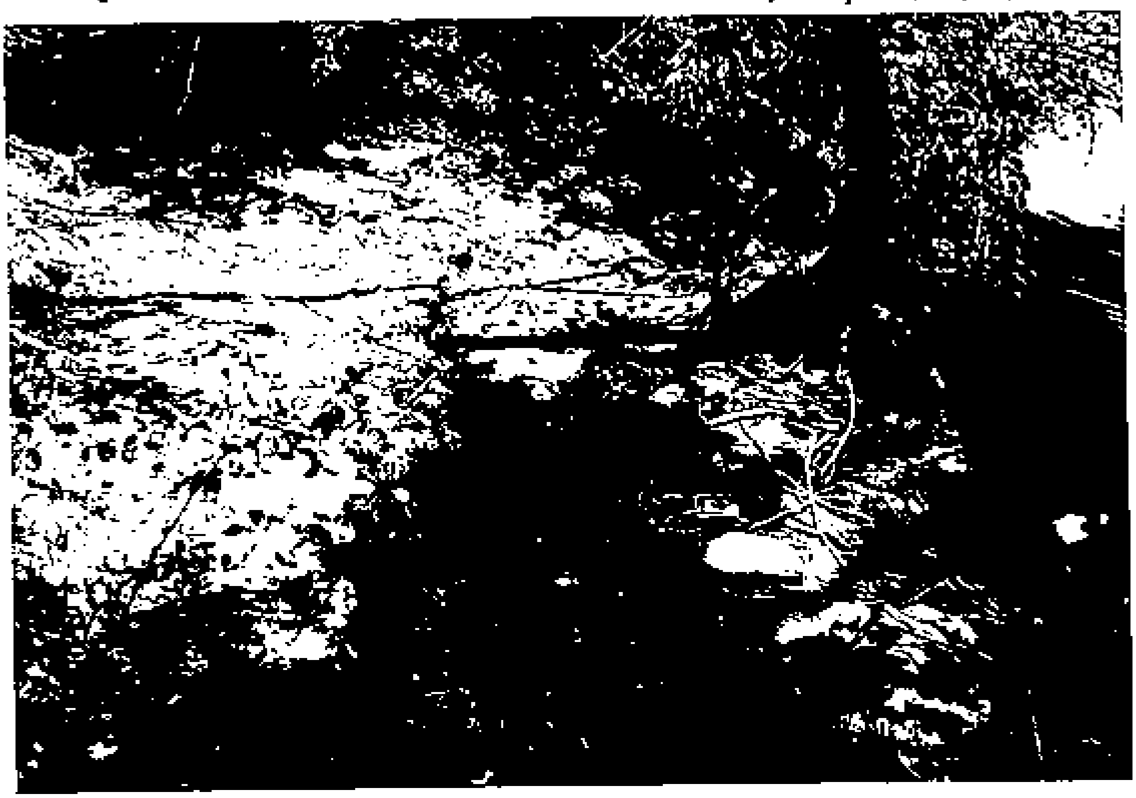


PHOTO 4-6 Area of "Yellow" Seepage at Edge of River Below Toe of Outside Slope of Units 1-4 Old Ash Basin Dike

PHOTO 4-7 Scoured Bank Next to River Below Toe of Outside Slope of Units 1-4 Old Ash Basin Dike

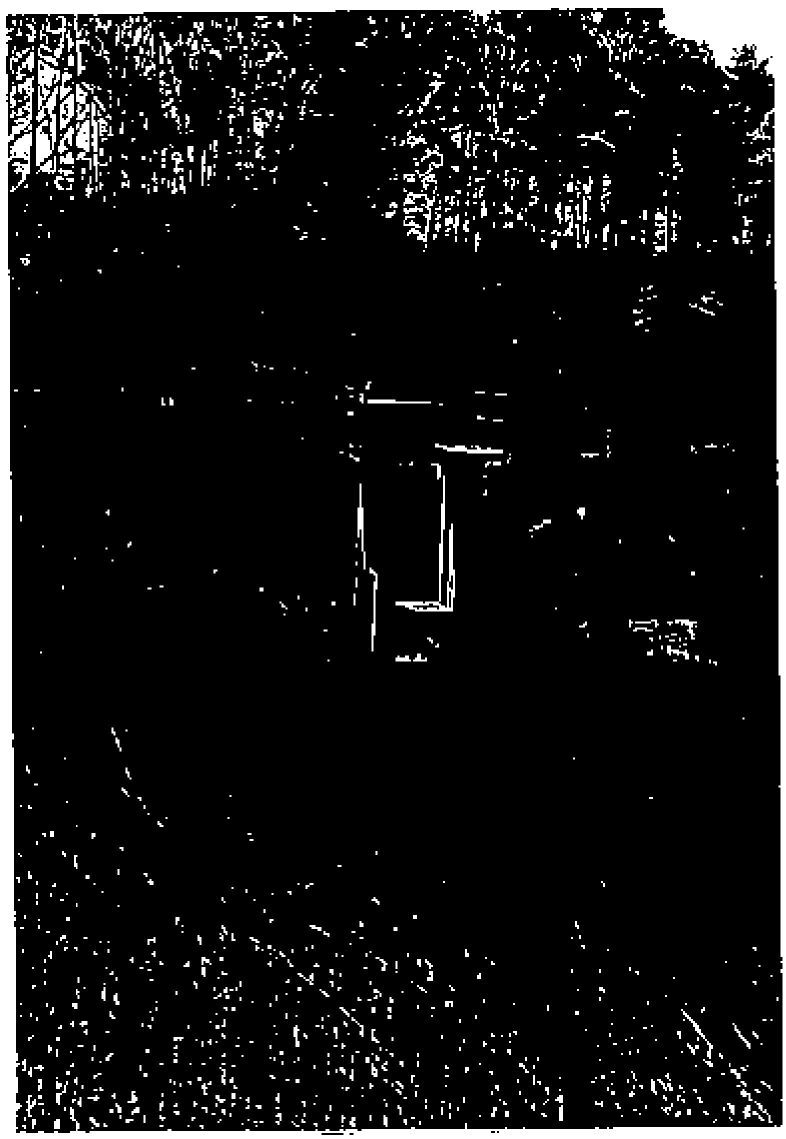


PHOTO 4-8 View of Units 1-4 Old Ash Basin Drainage Tower

PHOTO 4-9 Outlet End of 30-Inch CMP Outlet for Units 1-4 Old Ash Basin

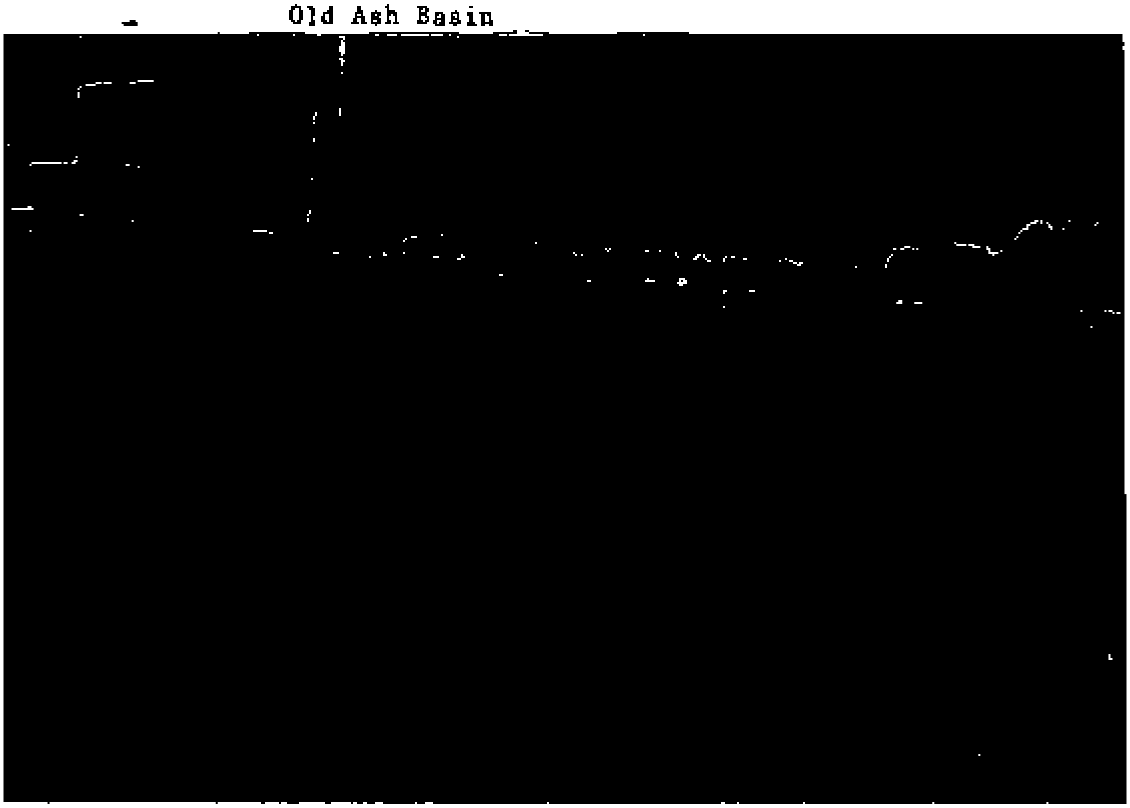


PHOTO 4-10 Outside (Downstream) Slope of Unit 5 Retired Basin Main Dike

PHOTO 4-11 Area of Seepage and Standing Water at Base of [illegible]

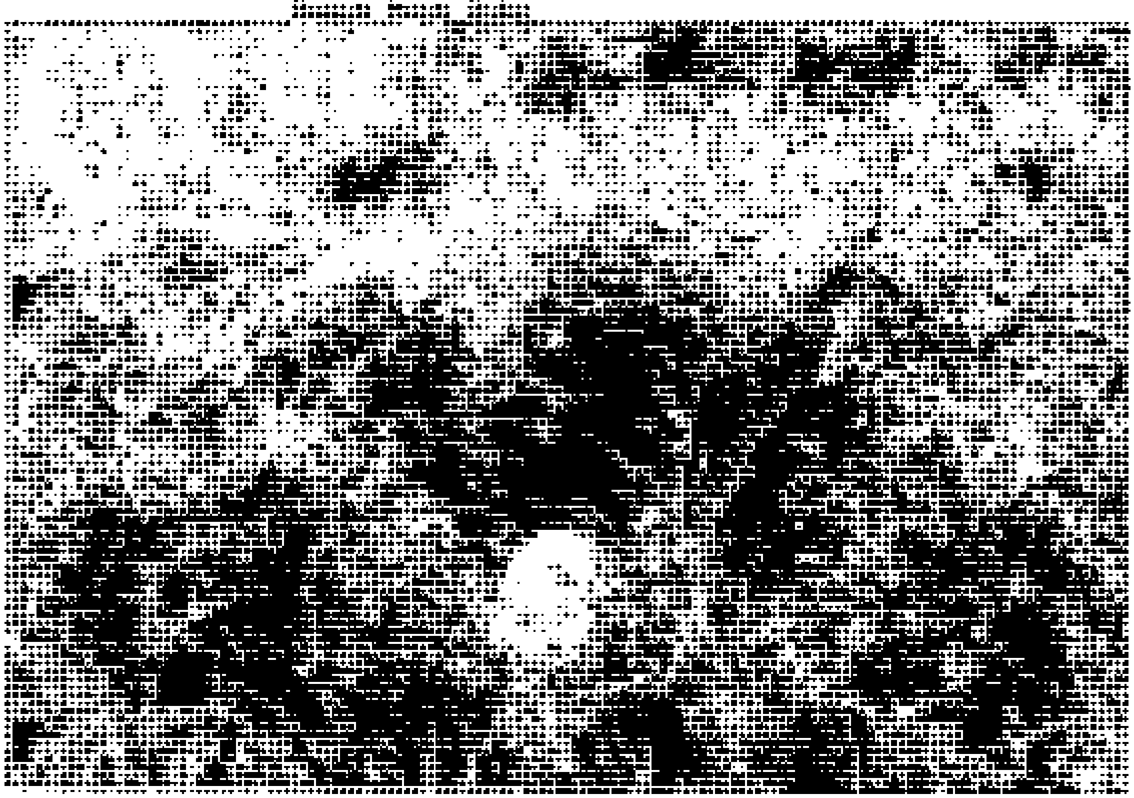


PHOTO 4-12 Eroded Hole in Downstream Slope of Unit 5 Retired Basin Saddle Dike

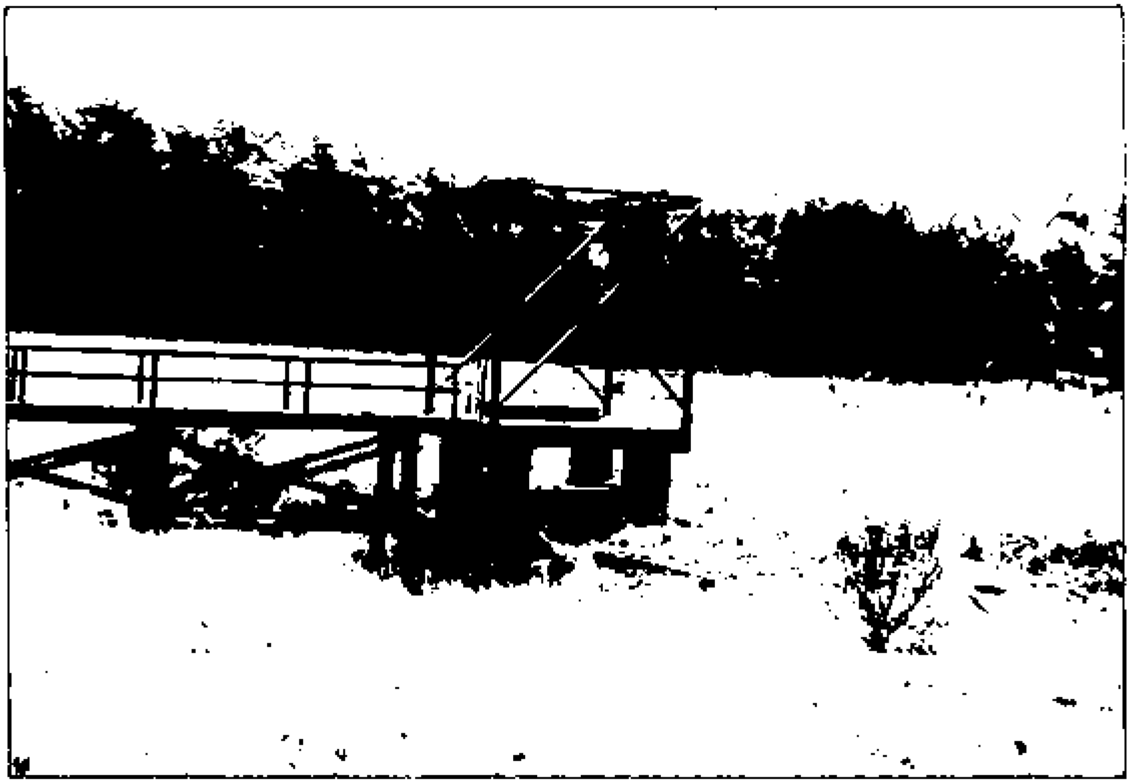


PHOTO 4-13 View of Unit 5 Retired Ash Basin Drainage Tower

PHOTO 4-14 Outlet End of 60-Inch RCP Outlet for Unit 5 Retired Ash Basin

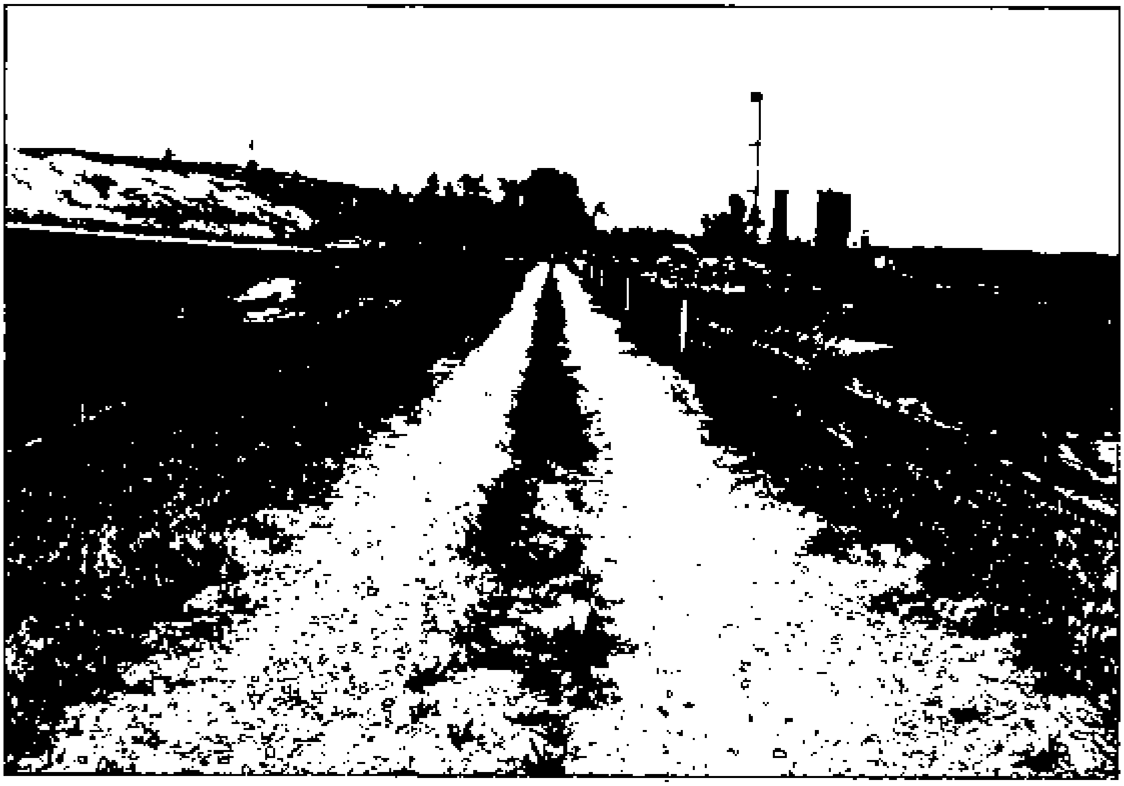


PHOTO 4-15 Crest of Suck Creek Downstream Dike (E to W View)

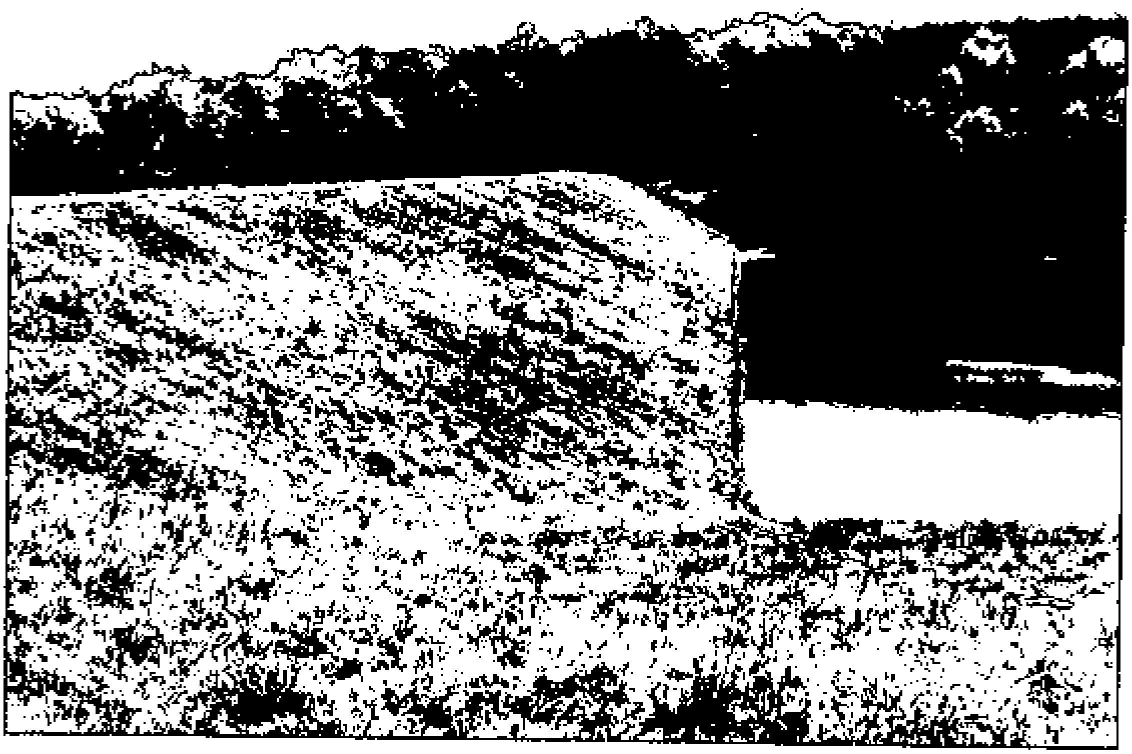


PHOTO 4-16 Inside Slope of Suck Creek Downstream Dike (W to E View)

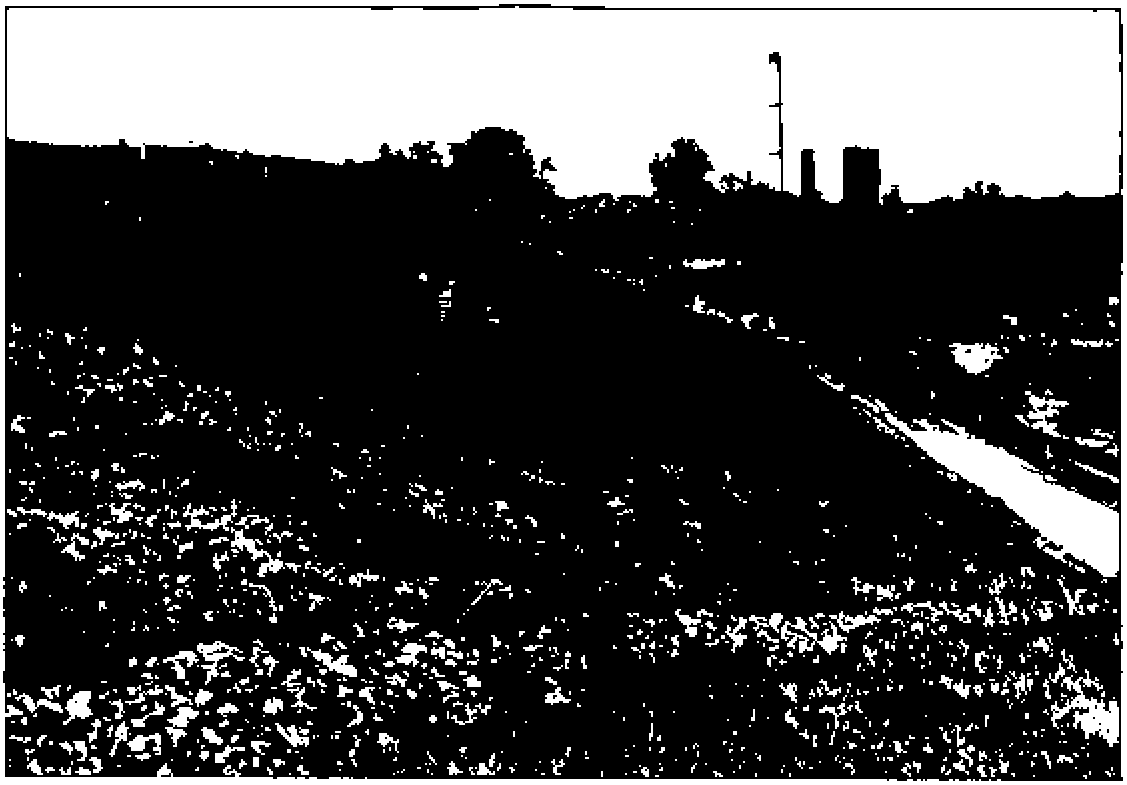


PHOTO 4-17 Outside Slope of Suck Creek Downstream Dike (E to W View)

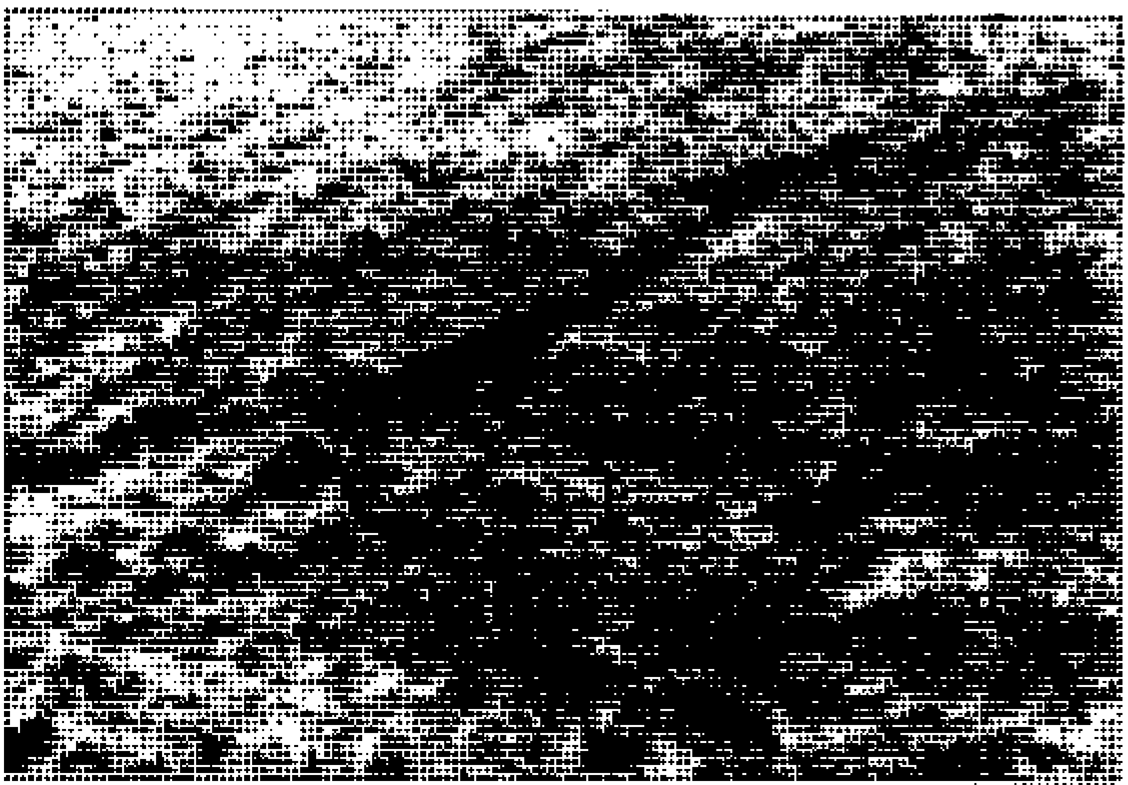


PHOTO 4-18 Old Eroded Area on Outside Slope of Suck Creek Downstream Dike

PHOTO 4-19 View of Upper Berm on Outside Slope of Suck Creek Downstream Dike (E to W View)

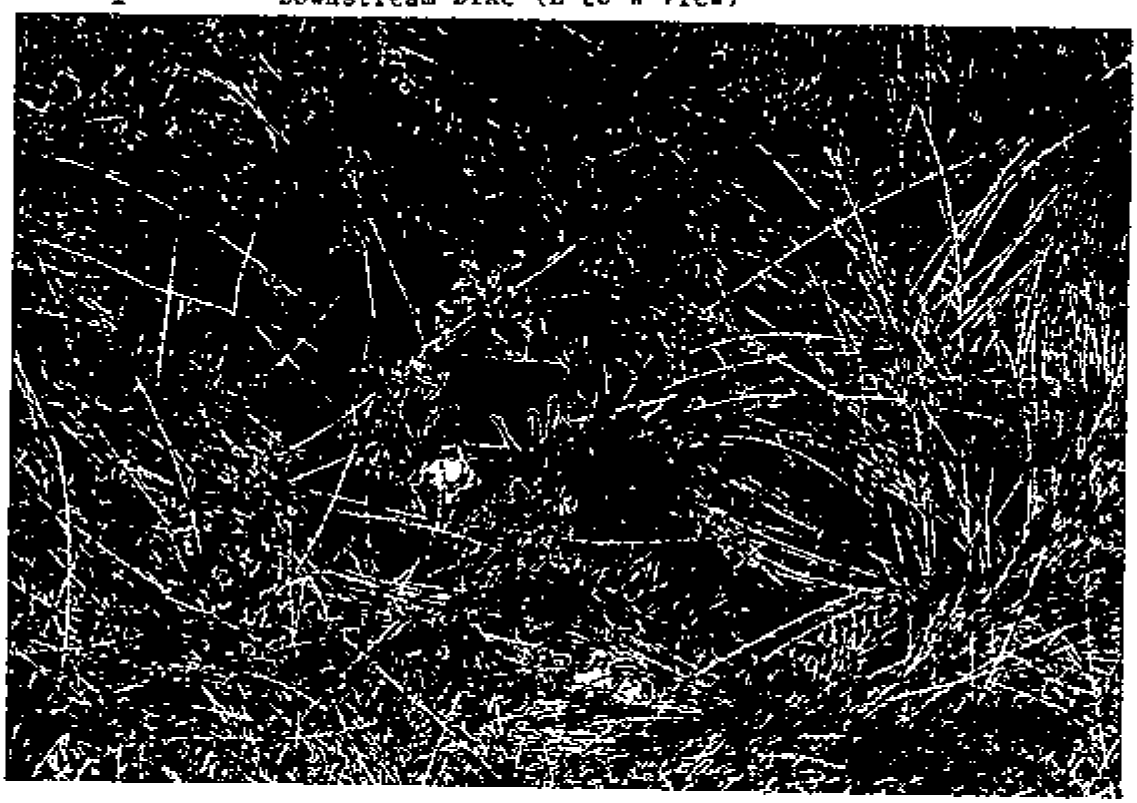


PHOTO 4-20 Small Slump in Embankment Slope Near Left (West) Abutment Just Below Upper Berm on Outside Slope of Suck Creek Downstream Dike

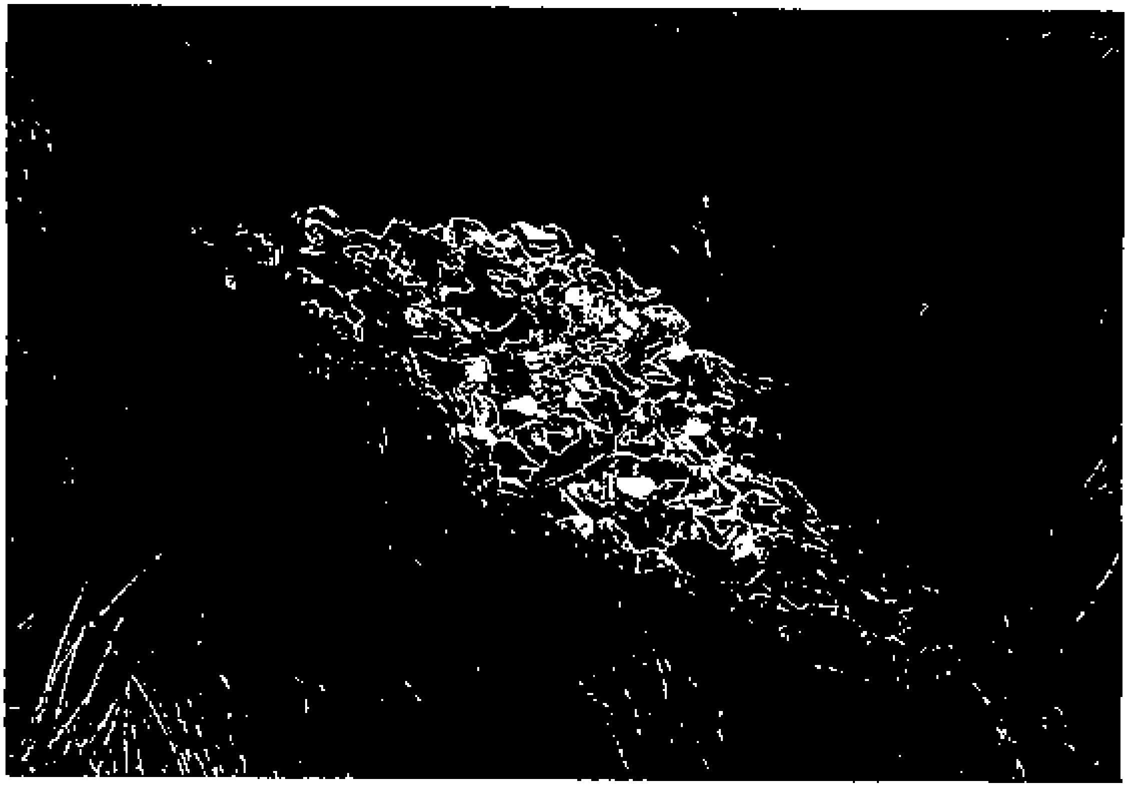


PHOTO 4-21 Riprap Blanket Over Previously Repaired Slump Near the Small Slump Shown in Photo 4-20

PHOTO 4-22 Riprapped Channel Below Toe of Outside Slope of Suck Creek Downstream Dike

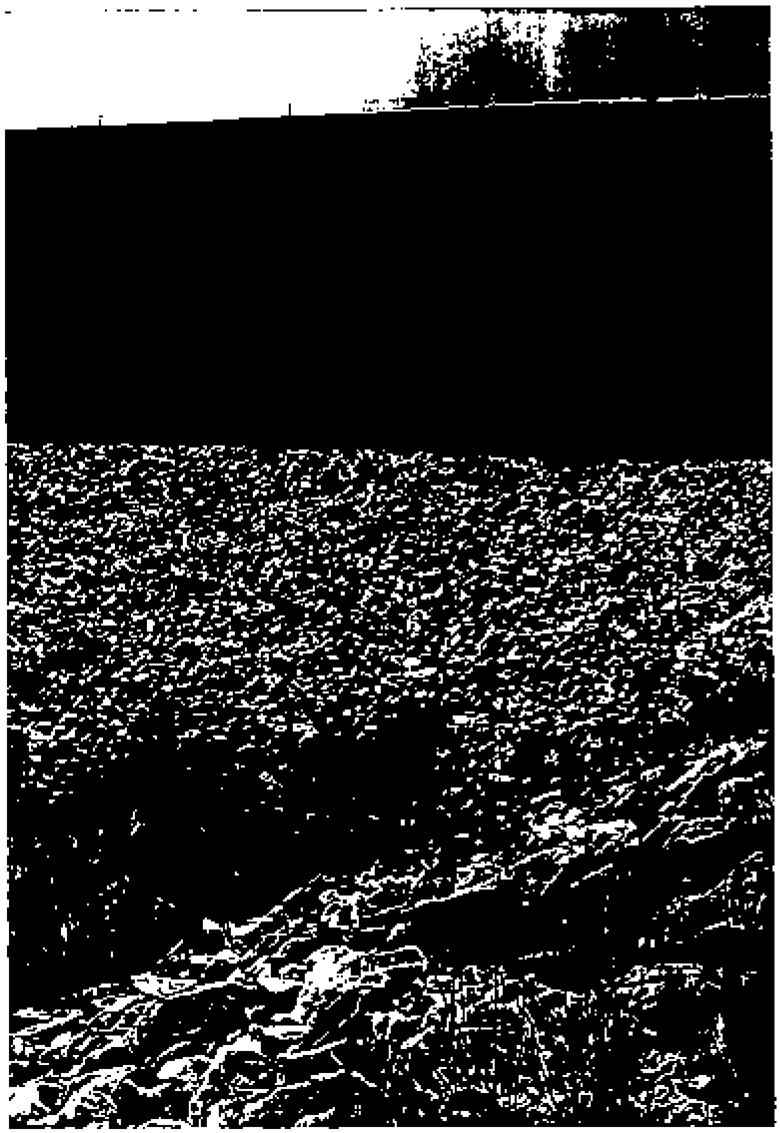


PHOTO 4-23 Toe of Outside Slope of Suck Creek Downstream Dike

PHOTO 4-24 Clear Seepage Emerging From Under Riprap at Base of Left (West) Bank Near End of Channel Shown in Photo 4-22

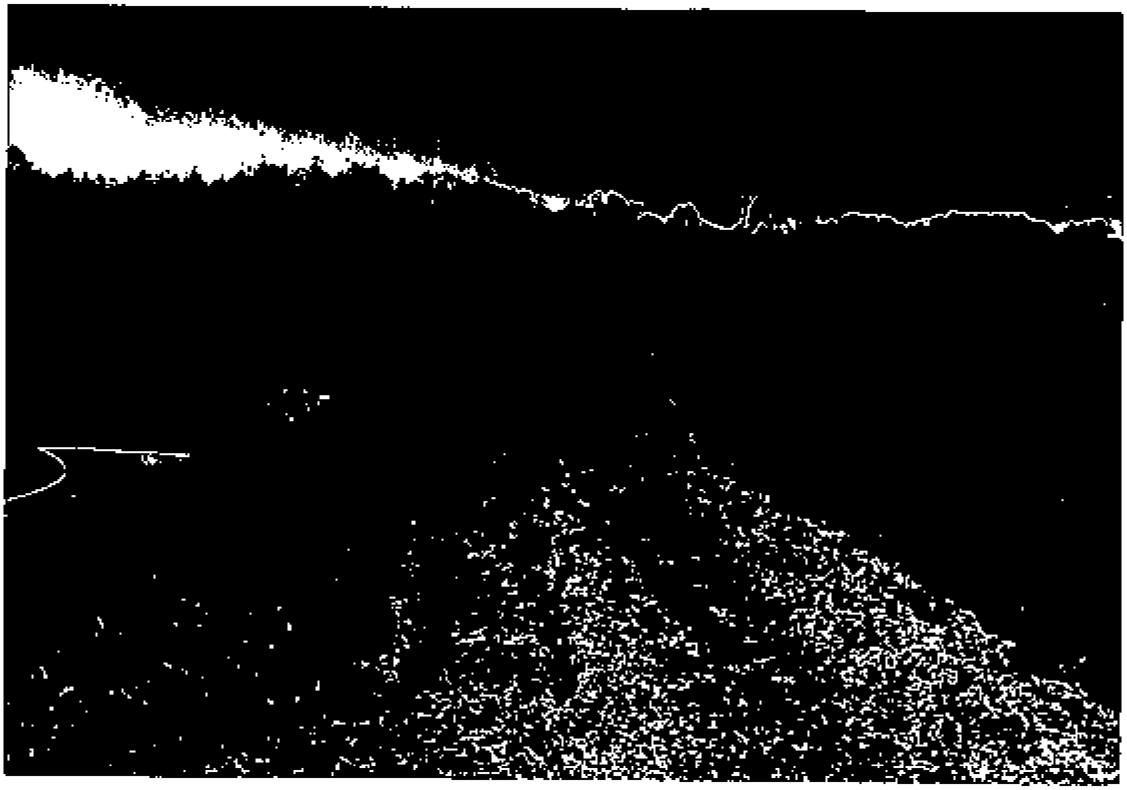


PHOTO 4-25 Crest of Suck Creek Upstream Dike (NE to SW View)

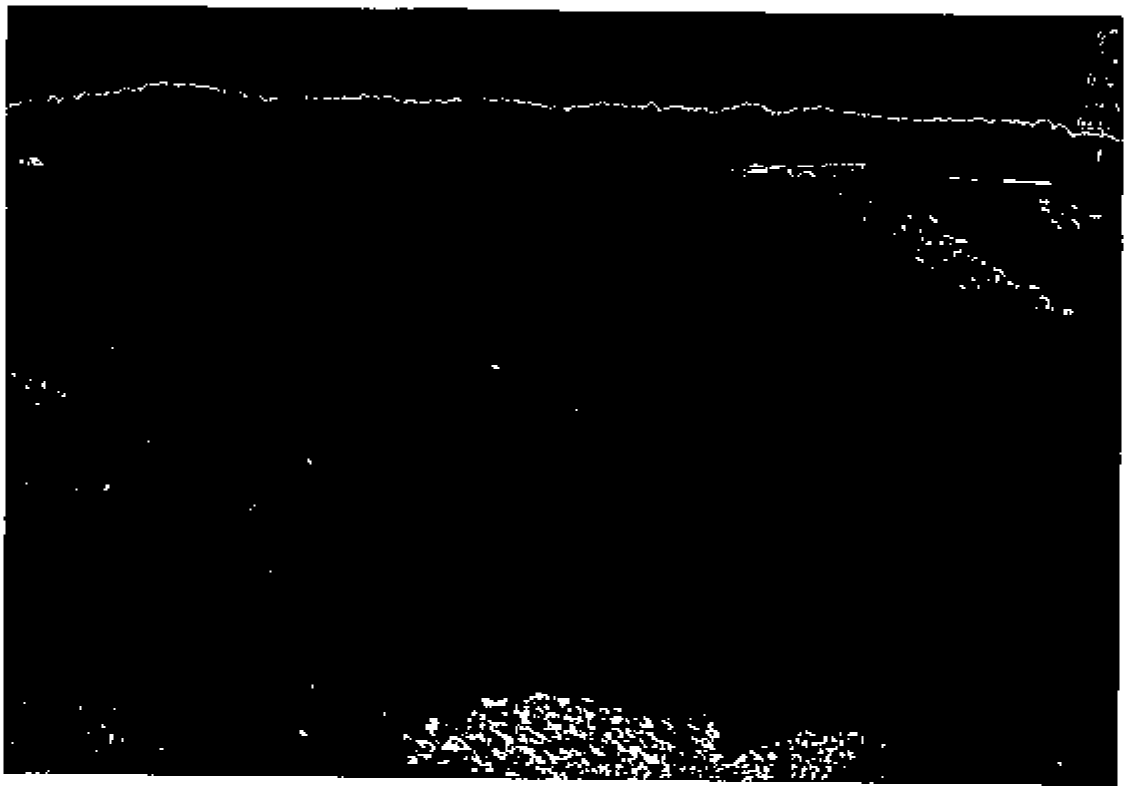


PHOTO 4-26 Inside Slope of Suck Creek Upstream Dike
(SW to NE View)

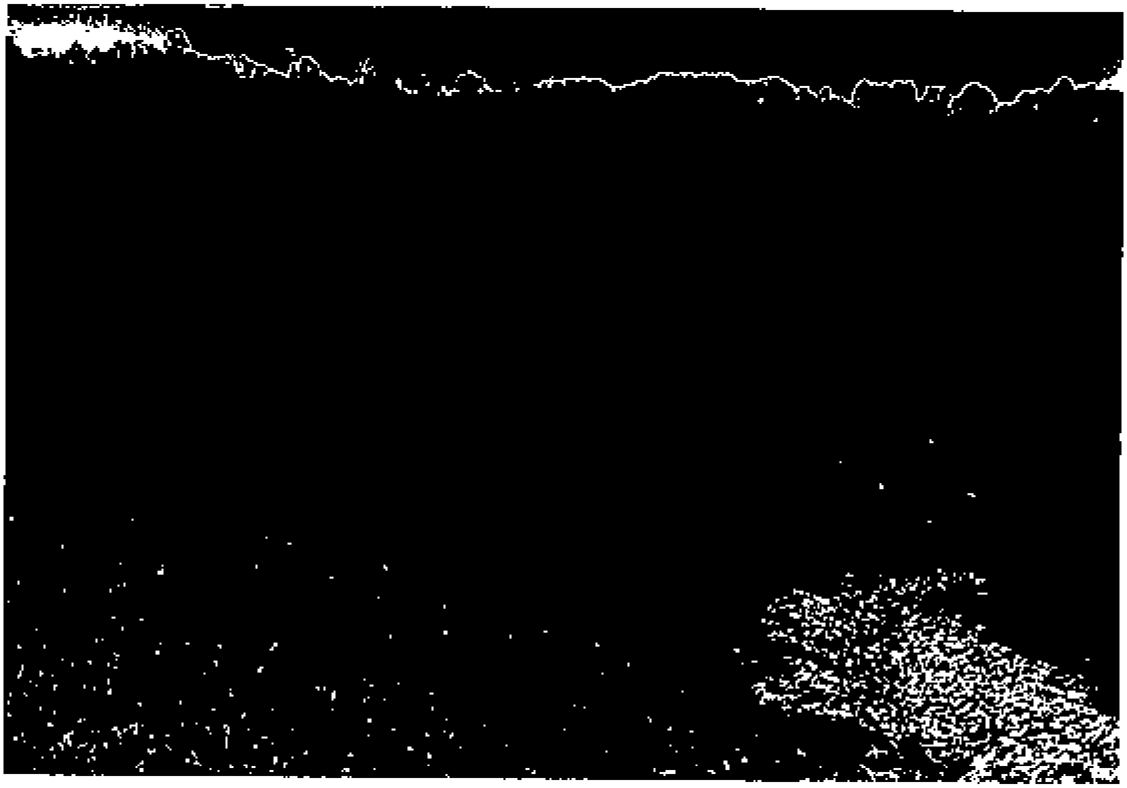


PHOTO 4-27 Outside Slope of Suck Creek Upstream Dike
(NE to SW View)

PHOTO 4-28 Wet Area Beyond Riprapped Toe of Outside Slope
of Suck Creek Upstream Dike

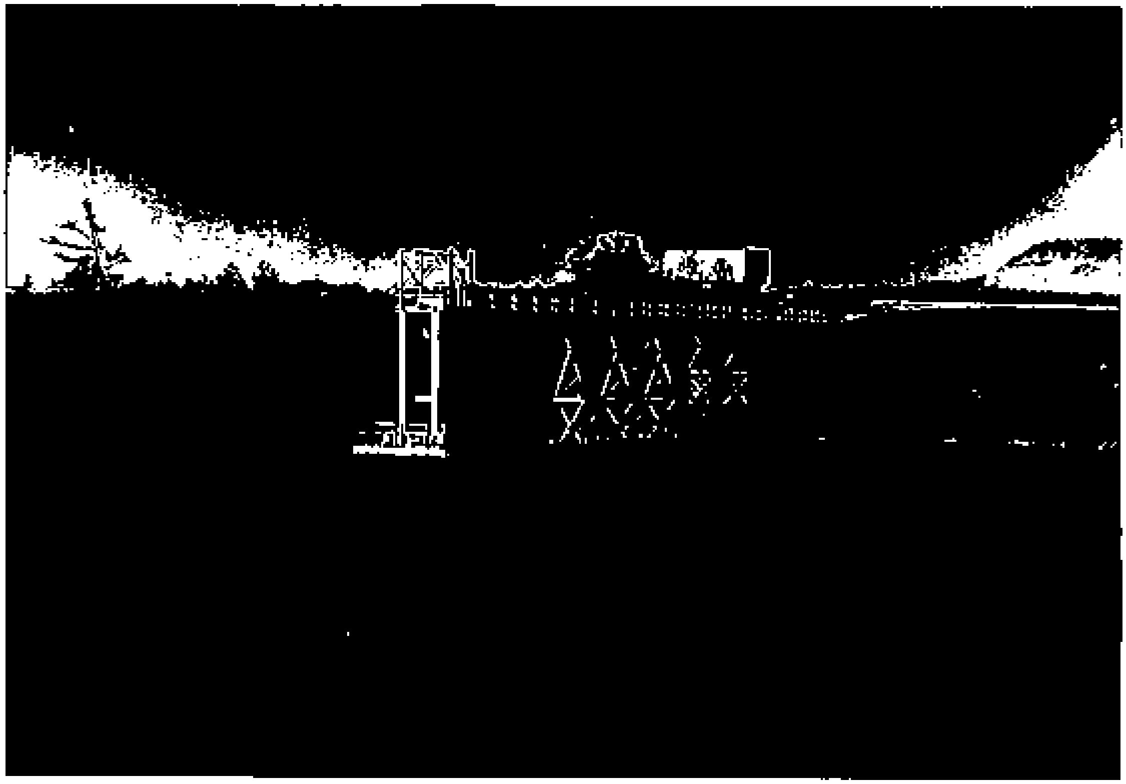


PHOTO 4-29 View of Suck Creek Ash Basin Drainage Tower

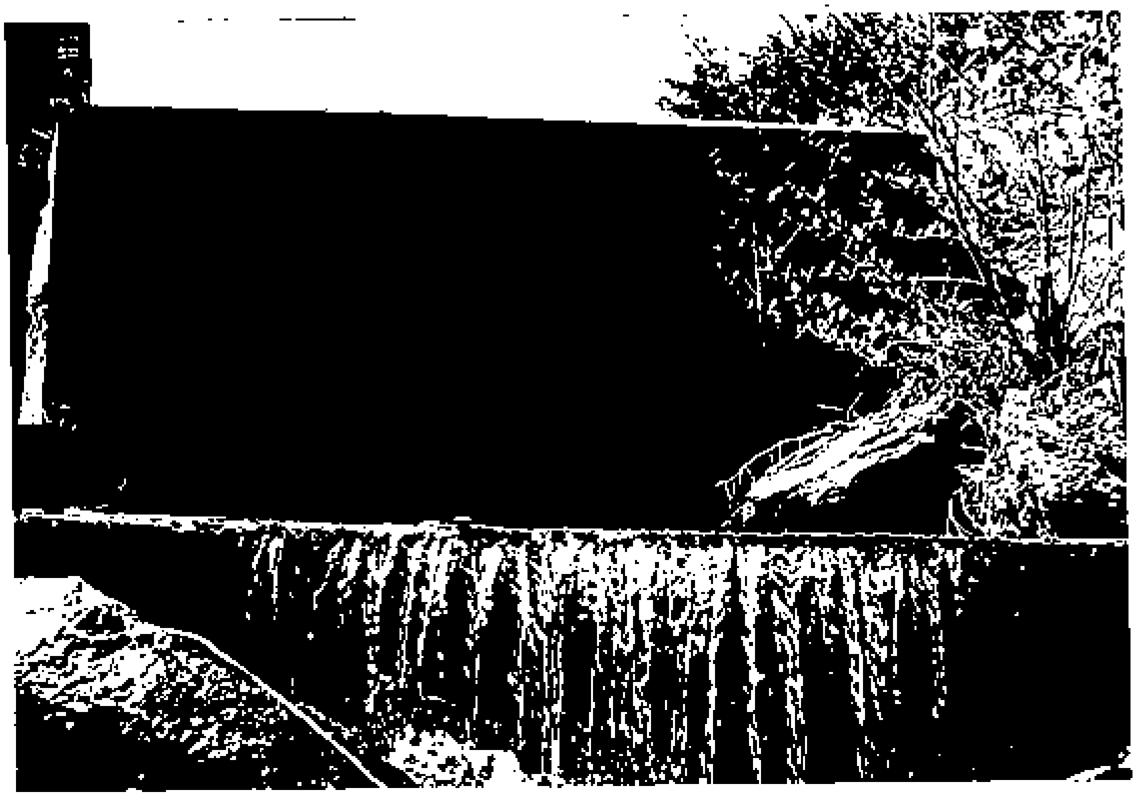
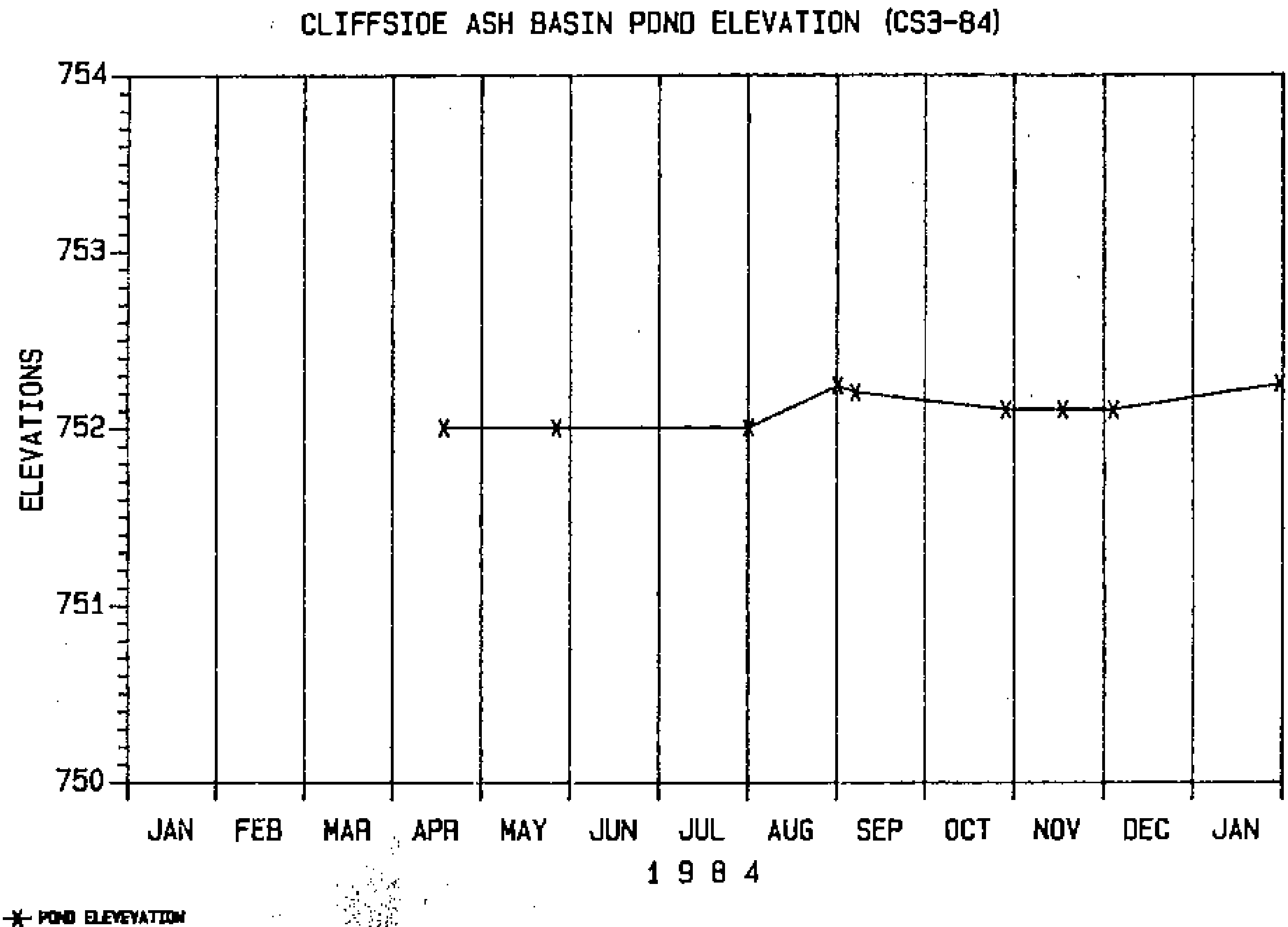


PHOTO 4-30 Outlet End of 42-Inch RCP Outlet for Suck Creek Ash Basin

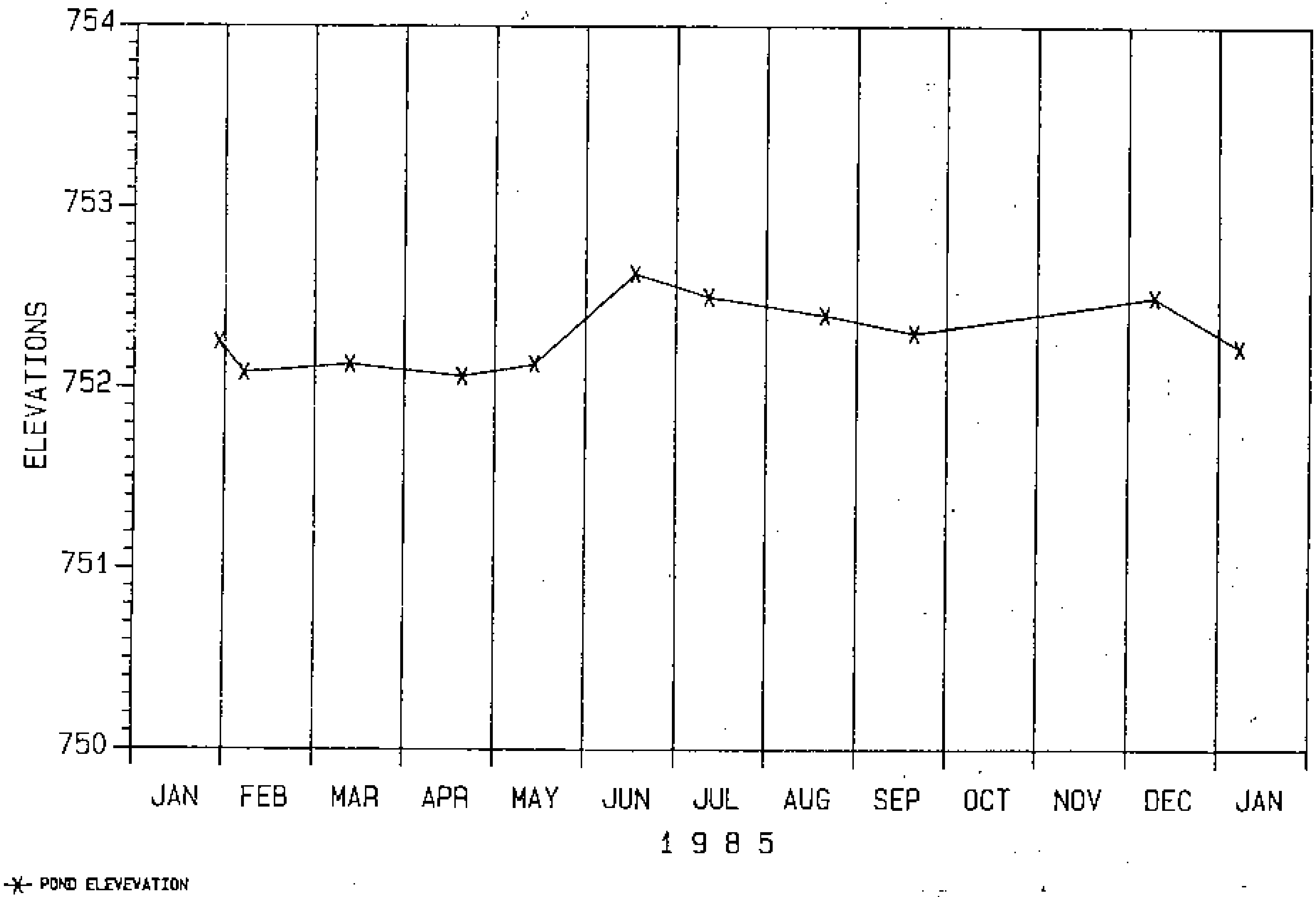
APPENDIX C

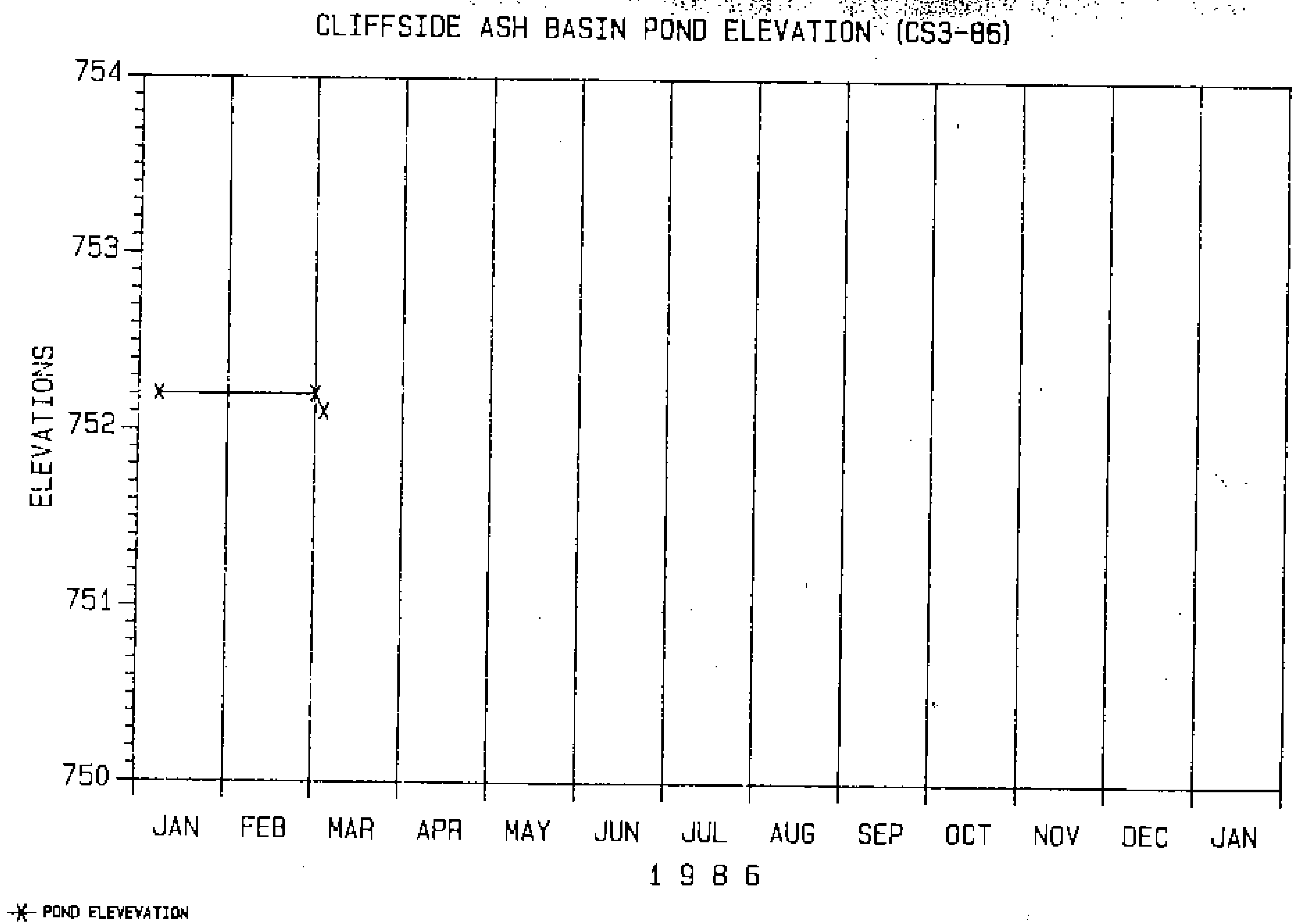
MONITORING DATA

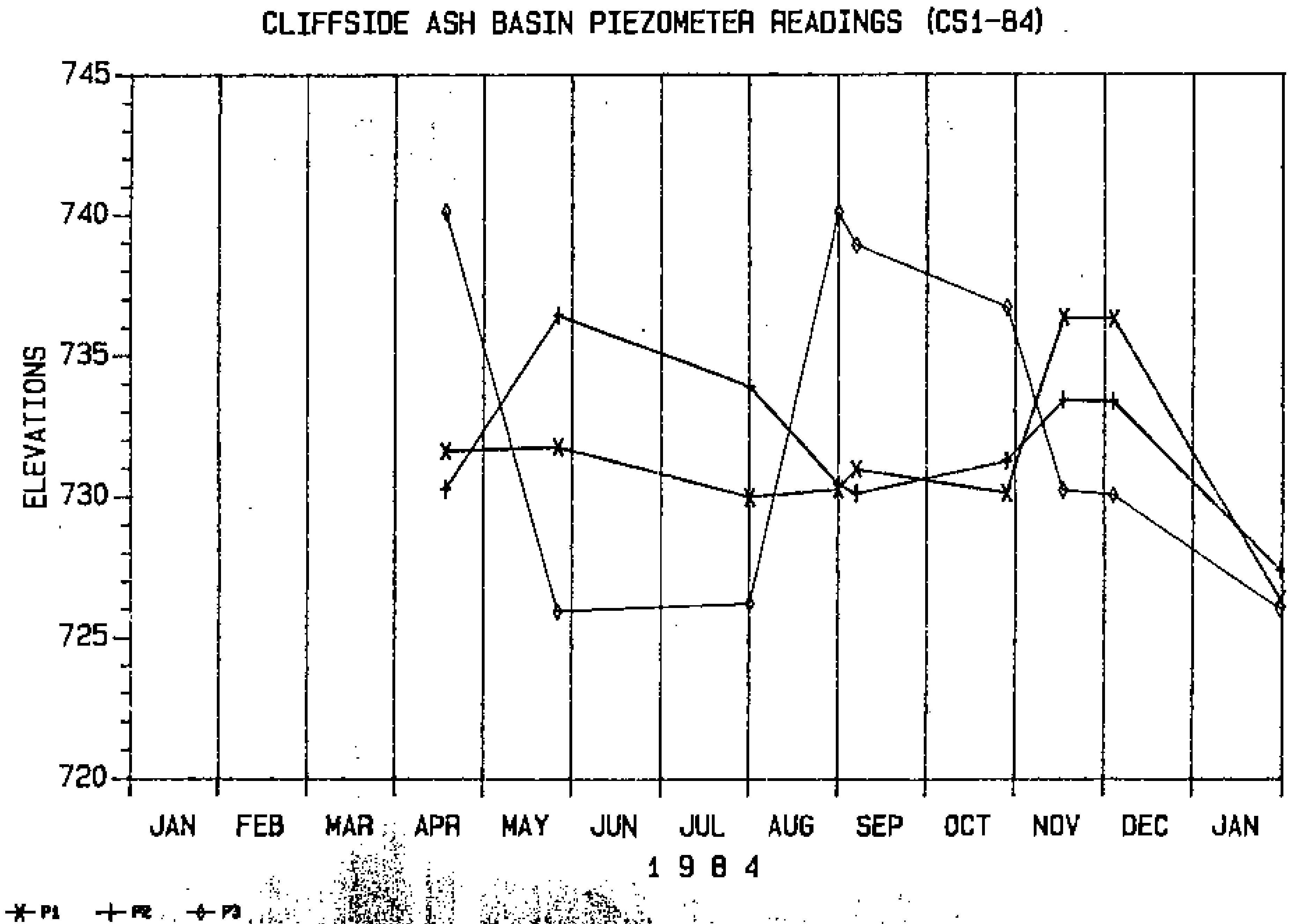


CLIFFSIDE ASH BASIN POND ELEVATION (CS3-84)
754
753
752
751
750
ELEVATIONS
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
1 9 8 4
POND ELEVATION

CLIFFSIDE ASH BASIN POND ELEVATION (CS3-85)

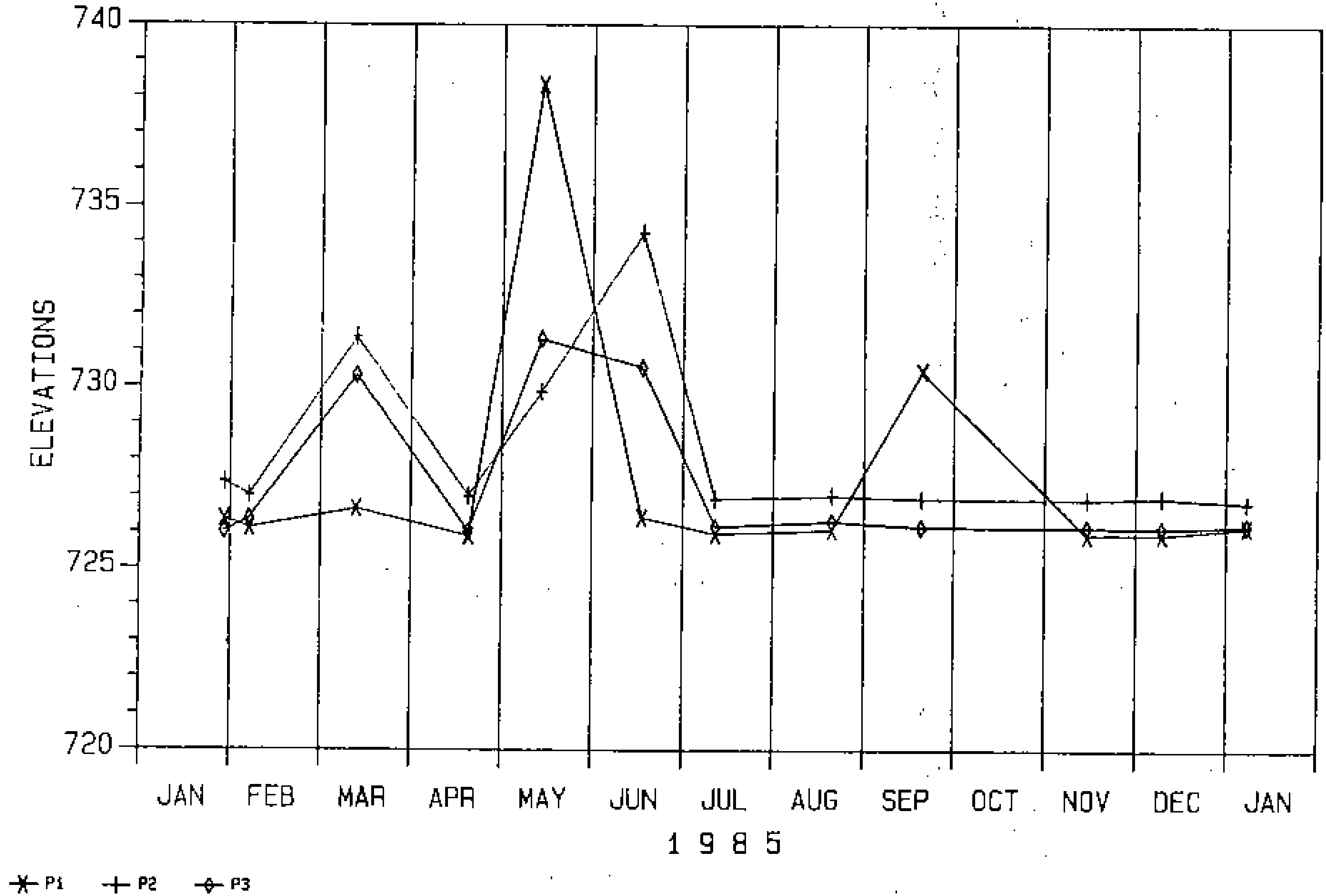



CLIFFSIDE ASH BASIN POND ELEVATION (CS3-86)
754
753
752
751
750
ELEVATIONS
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
1 9 8 6
POND ELEVEVATION

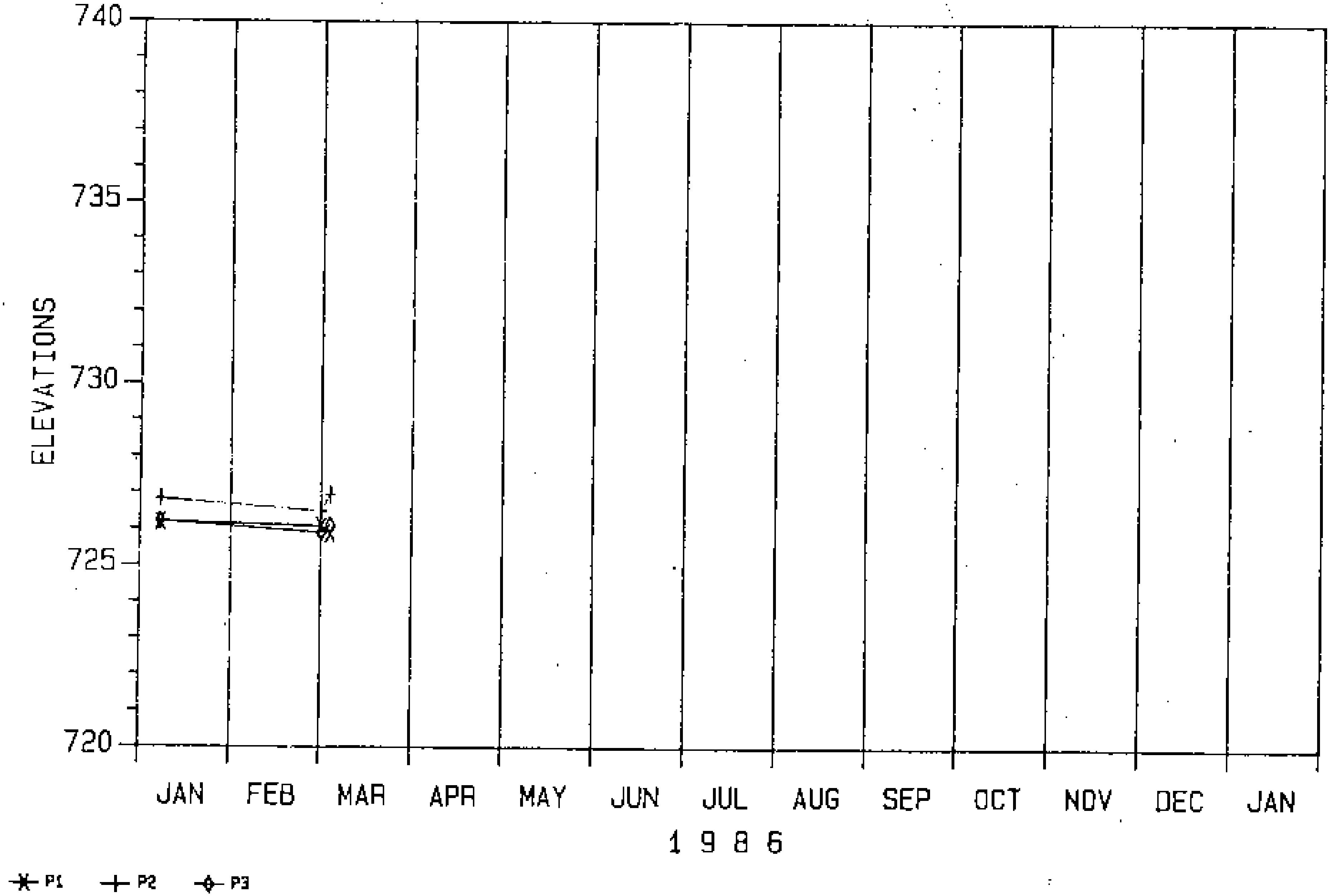


CLIFFSIDE ASH BASIN PIEZOMETER READINGS (CS1-84)
ELEVATIONS
745
740
735
730
725
720
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
1 9 8 4
P1
P2
P3

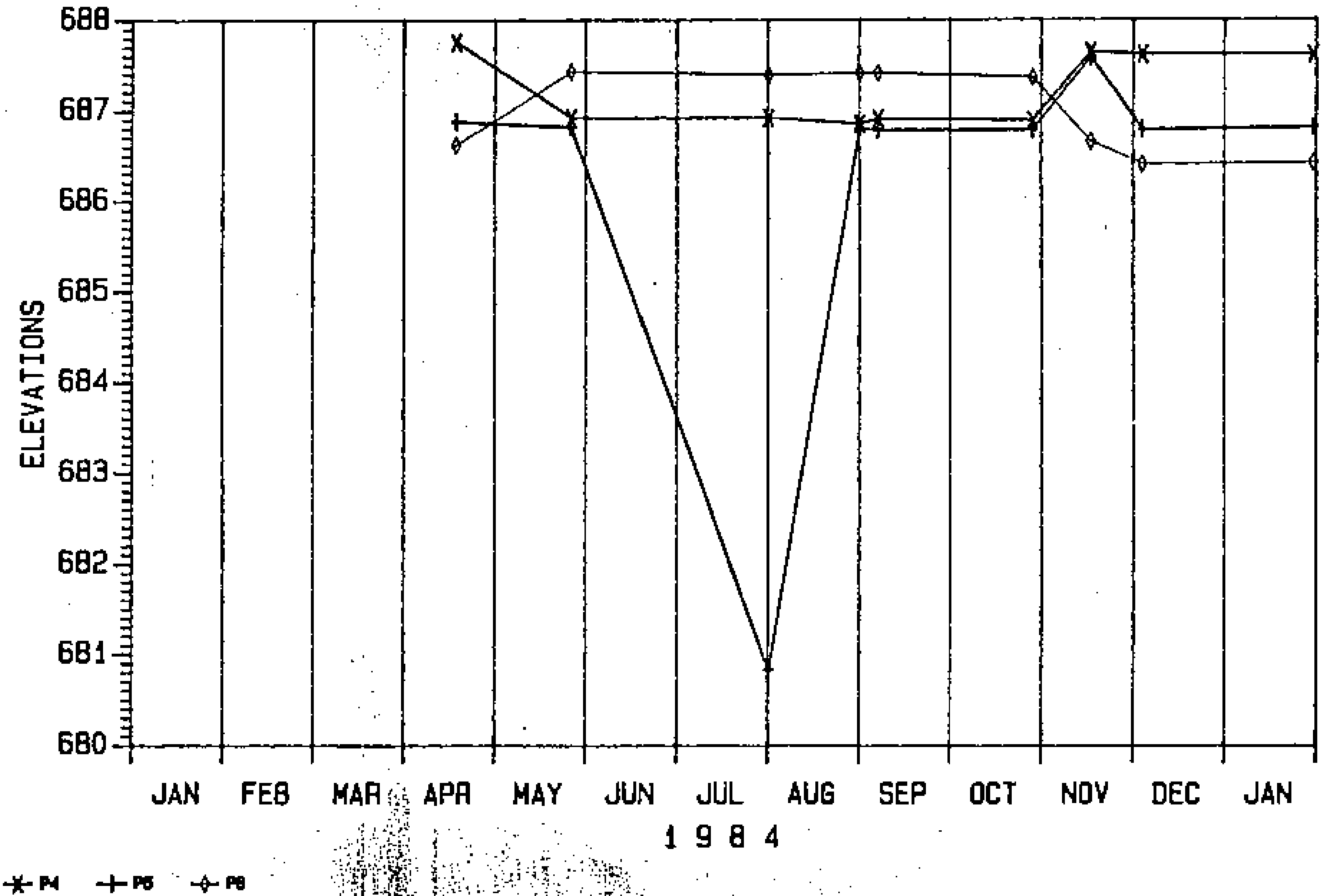
CLIFFSIDE ASH BASIN PIEZOMETER READINGS (CS1-85)



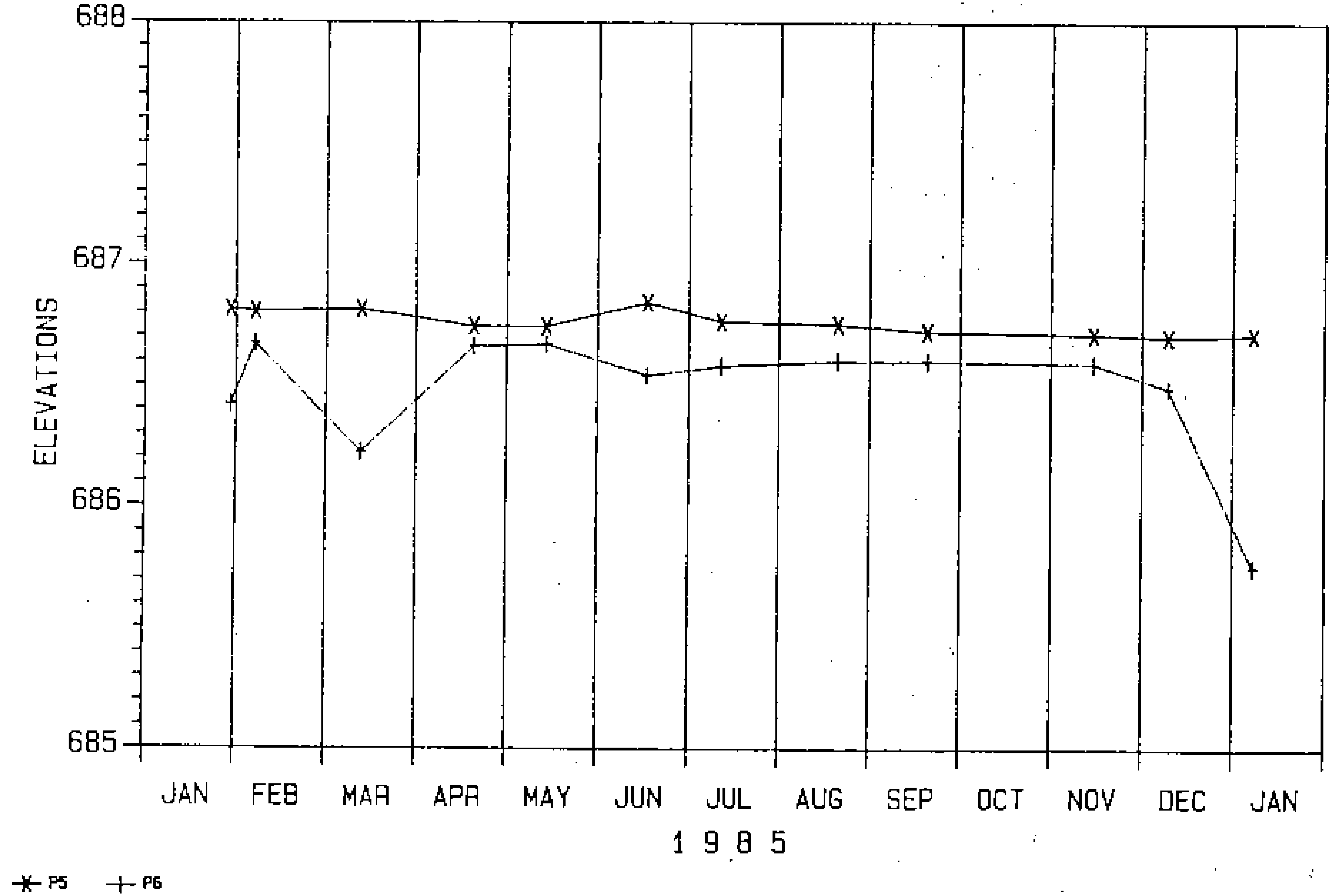
CLIFFSIDE ASH BASIN PIEZOMETER READINGS (CS1-86)

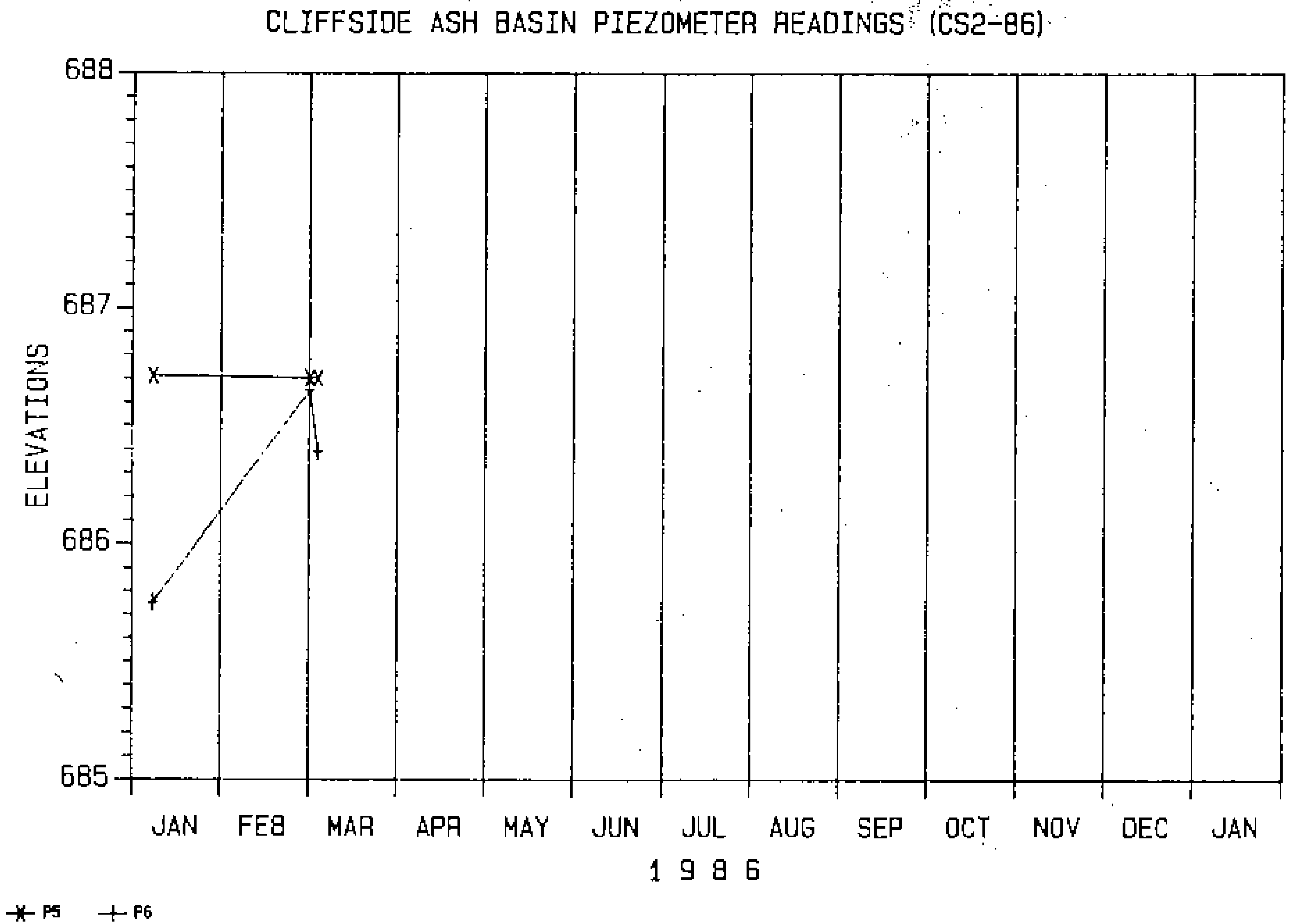


CLIFFSIDE ASH BASIN PIEZOMETER READINGS (CS2-84)



CLIFFSIOE ASH BASIN PIEZOMETER READINGS (CS2-85)




CLIFFSIDE ASH BASIN PIEZOMETER READINGS (CS2-86)
688
687
686
685
ELEVATIONS
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
1 9 8 6
P5
P6

SGC

JCL As handle.
SGC Appr 4/20

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: David W Olney Date of Observation: 4-17-84

Piezometer Number	Location Station	Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	752.00	46.51	731.59
C-2	13 + 35	8' DS	778.4	752.00	48.13	730.27
C-3	14 + 35	8' DS	778.2	752.00	38.09	740.11
C-4	12 + 35	150' DS	728.8	752.00	41.05	687.75
C-5	13 + 35	150' DS	728.7	752.00	41.83	686.87
C-6	14 + 35	150' DS	728.5	752.00	41.89	686.61

JCL 4/26/84

Notes:
1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-L.
2) All water elevations to be read correct to .01 Feet.
3) Frequency of Observations: monthly intervals.
4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

UOAF

~~ASE/SGE~~

Done 6/18/84 watyp

JUN 1 1 1984

FILE NO. C-5424.00

C-2804

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: David Olary Date of Observation: 5-25-84

Piezometer Number	Location Station	Location Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	752.00	46.35	731.75
C-2	13 + 35	8' DS	778.4	752.00	41.97	736.43
C-3	14 + 35	8' DS	778.2	752.00	52.28	725.92
C-4	12 + 35	150' DS	728.8	752.00	41.89	686.91
C-5	13 + 35	150' DS	728.7	752.00	41.89	686.81
C-6	14 + 35	150' DS	728.5	752.00	41.07	687.43

Notes: 1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-L.

2) All water elevations to be read correct to .01 Feet.

3) Frequency of Observations: monthly intervals.

4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

~~Wes~~/TRM
I would like to review monitoring data 8/8 at 2:00 pls advise if this is acceptable. RBG 8/6

~~RSB~~/SGC

I have conflict TRM Handle ~~[illegible]~~ 8/7

CIVIL [illegible]
RECEIVED
AUG 06 1984
DIVISION/RECORDS COPY
FILE NO. C-5434.00
C-280A

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: David Olney   Date of Observation: 7-31-84

Piezometer Number	Location Station	Location Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	752.00	48.16	729.94
C-2	13 + 35	8' DS	778.4	752.00	44.52	733.88
C-3	14 + 35	8' DS	778.2	752.00	51.99	726.21
C-4	12 + 35	150' DS	728.8	752.00	41.89	686.91
C-5	13 + 35	150' DS	728.7	752.00	47.88	680.82
C-6	14 + 35	150' DS	728.5	752.00	41.11	687.39

Notes:
1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-L.
2) All water elevations to be read correct to .01 Feet.
3) Frequency of Observations: monthly intervals.
4) Send one copy of completed readings to: R. S. Bhatnagar, Design Engineering

TKK SGC

Aug, 84

SEP 07 1984

FILE NO. CS-5494.00

CS-290A

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: Dave Olney Date of Observation: 8-31-84

Piezometer Number	Location		Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
	Station	Offset				
C-1	12 + 35	8' DS	778.1	752.24	47.56	730.54
C-2	13 + 35	8' DS	778.4	752.24	48.00	730.40
C-3	14 + 35	8' DS	778.2	752.24	38.11	740.09
C-4	12 + 35	150' DS	728.8	752.24	41.91	686.89
C-5	13 + 35	150' DS	728.7	752.24	41.90	686.80
C-6	14 + 35	150' DS	728.5	752.24	41.09	687.41

Notes:
1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-L.
2) All water elevations to be read correct to .01 Feet.
3) Frequency of Observations: monthly intervals.
4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

TRM

~~SGC~~

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: Dave Olney   Date of Observation: 9-6-84

Piezometer Number	Location Station	Location Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	752.20	47.15	730.95
C-2	13 + 35	8' DS	778.4	752.20	48.32	730.08
C-3	14 + 35	8' DS	778.2	752.20	39.29	738.91
C-4	12 + 35	150' DS	728.8	752.20	41.90	686.90
C-5	13 + 35	150' DS	728.7	752.20	41.92	686.78
C-6	14 + 35	150' DS	728.5	752.20	41.09	687.41

Notes: 1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-L.

2) All water elevations to be read correct to .01 Feet.

3) Frequency of Observations: monthly intervals.

4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

RSB/SGC JRN

CIVIL ... OCT 3 1 1984 ... FILE NO. C ...

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: David Olay   Date of Observation: 10-29-84

Piezometer Number	Location Station	Location Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	752.10	48.00	730.10
C-2	13 + 35	8' DS	778.4	752.10	47.15	731.25
C-3	14 + 35	8' DS	778.2	752.10	41.50	736.70
C-4	12 + 35	150' DS	728.8	752.10	41.91	686.88
C-5	13 + 35	150' DS	728.7	752.10	41.92	686.78
C-6	14 + 35	150' DS	728.5	752.10	41.14	687.36

Notes: 1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-

2) All water elevations to be read correct to .01 Feet.

3) Frequency of Observations: monthly intervals.

4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

TRM

~~SEE~~

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: David Oley   Date of Observation: 11-16-84

Piezometer Number	Location Station	Location Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	502.10 ? 752.10	41.75	736.35
C-2	13 + 35	8' DS	778.4	502.10	44.98	733.42
C-3	14 + 35	8' DS	778.2	502.10	48.00	730.20
C-4	12 + 35	150' DS	728.8	502.10	41.16	687.64
C-5	13 + 35	150' DS	728.7	502.10	41.11	687.59
C-6	14 + 35	150' DS	728.5	502.10	41.85	686.65

Notes: 1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-L.

2) All water elevations to be read correct to .01 Feet.

3) Frequency of Observations: monthly intervals.

4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

TRM

~~SGC~~

DEC 2 6 1984

FILE NO. CS-5148.00

CS-5434.00

CS-2800A

CLIFFSIDE STEAM STATION
PIEZOMETER READINGS IN
SUCK CREEK DOWNSTREAM ASH DAM

Name of Observer: David Olary   Date of Observation: 12-3-84

Piezometer Number	Location Station	Location Offset	Elevation Top of Piezometer Tube	Basin Water Elevation	Observed Distance Top of Casing Pipe To Water Surface	Elevation Of Water In Piezometer
C-1	12 + 35	8' DS	778.1	752.10	41.80	736.30
C-2	13 + 35	8' DS	778.4	752.10	45.03	733.32
C-3	14 + 35	8' DS	778.2	752.10	48.16	730.04
C-4	12 + 35	150' DS	728.8	752.10	41.19	687.61
C-5	13 + 35	150' DS	728.7	752.10	41.92	686.78
C-6	14 + 35	150' DS	728.5	752.10	42.10	686.40

Notes:
1) Piezometers are shown on drawing C-2015A and detailed on drawing C-2015-1.
2) All water elevations to be read correct to .01 Feet.
3) Frequency of Observations: monthly intervals.
4) Send one copy of completed readings to: R. S. Bhatnagar
Design Engineering

DUKE POWER COMPANY
BUCK CREEK ASH BASIN
PIEZOMETER READINGS

File No: ~~CS-5434.00~~, CS-280A

>SGC

CIVIL SUPPORT SECTION
RECEIVED
DEC 1 1 1985

ELEVATION TOP OF PIEZOMETER TUBE (Ft.)	NUMBER	TYPE	DATE: 1-24-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 2-6-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 3-11-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 4-18-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 5-21-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 6-12-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 7-11-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: 8-10-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: [illegible]-85 POND ELEV.: [illegible] OBSERVER: DWO	DATE: [illegible] POND ELEV.: [illegible] OBSERVER: DWO	DATE: [illegible] POND ELEV.: [illegible] OBSERVER: DWO	DATE: POND ELEV.: OBSERVER:

DISTANCE FROM TOP OF CASING PIPE TO WATER SURFACE (Ft.)

778.1	1	P	51.75	52.00	51.46	52.21	39.76	51.71	52.15	52.02	47.65	52.17	52.15	
778.4	2	P	51.02	51.40	47.03	51.41	48.53	44.13	51.49	51.39	51.48	51.50	51.44	
778.2	3	P	52.19	51.83	47.88	52.19	46.88	47.67	52.05	51.90	52.05	52.06	52.09	
728.8	4	P	41.19	□	□	□	□	□	□	□	□	□	□	
728.7	5	P	41.89	41.90	41.89	41.96	41.96	41.86	41.94	41.95	41.98	41.99	42.00	
728.5	6	P	42.08	41.83	41.88	41.84	41.83	41.96	41.92	41.90	41.90	41.91	42.01	

WATER ELEVATIONS (Ft.)

1	P	726.35	726.10	726.64	725.89	738.34	726.39	725.95	726.08	730.45	725.93	725.95	
2	P	727.38	727.00	731.37	726.99	729.87	734.27	726.91	727.01	726.92	726.90	726.96	
3	P	726.01	726.37	730.32	726.01	731.32	730.53	726.15	726.30	726.15	726.14	726.11	
4	P	687.61	□	□	□	□	□	□	□	□	□	□	
5	P	686.81	686.80	686.81	686.74	686.74	686.84	686.76	686.75	686.71	686.71	686.70	
6	P	686.42	686.67	686.22	686.66	686.67	686.54	686.58	686.60	686.60	686.59	686.49	

PARSHALL FLUME	(NOT APPLICABLE)										

NOTES:
1. All water surface elevations are to be correct to 0.01 of a foot.
2. Parshall Flume reading shall be gallons per minute and correct to the nearest 0.01 gpm.
3. Type: P - Piezometer, OW - Observation Well.
4. All Piezometer/Observation Wells are to be completed with an elevation. If no water exist, footnote the depth as follows: △ Wet silty bottom, □ Dry silt, ⌁ Hard bottom
5. Send a copy of completed forms, page 1 and 2, to: Design Engineering, Mr. S. B. Hager, Chief Engineer, Attention: R. S. Sills.
6. Station to retain original and complete the next column at the next monitoring interval.

~~ASBTSGC~~ TRM

CS-~~2800A~~ File ~~[illegible]~~ CS-5431.00

CIVIL SUPPORT [illegible]
RECEIVED
MAR 0 4 1986

ELEVATION TOP OF PIEZOMETER TUBE (Ft.)	NUMBER	TYPE	DATE: [illegible] POND ELEV.: [illegible] OBSERVER: DWO	DATE: [illegible] POND ELEV.: [illegible] OBSERVER: [illegible]	DATE: 3.3.86 POND ELEV.: [illegible] OBSERVER: DWO	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:	DATE: POND ELEV.: OBSERVER:
			DISTANCE FROM TOP OF CASING PIPE TO WATER SURFACE (Ft.)											
778.1	1	P	51.93	52.04	52.25									
778.4	2	P	51.59	51.42	51.46									
778.2	3	P	52.00	52.31	52.10									
728.8	4	P	◻	◻	◻									
728.7	-5	P	41.99	42.00	42.00									
728.5	6	P	42.75	41.85	42.11									
			WATER ELEVATIONS (Ft.)											
	1	P	726.17	726.06	725.85									
	2	P	726.81	726.98	726.94									
	3	P	726.20	725.89	726.1									
	4	P	◻	◻										
	5	P	686.71	686.70	686.7									
	6	P	685.75	686.65	686.39									
	PARSHALL FLUME		(NOT APPLICABLE)											

NOTES:
1. All water surface elevations are to be correct to 0.01 of a foot.
2. Parshall flume reading shall be gallons per minute and correct to the nearest 0.01 gpm.
3. Type: P - Piezometer, OW - Observation Well.
4. All Piezometer/Observation wells are to be completed with an elevation. If no water exist, footnote the depth as follows: △ Wet silty bottm, ◻ Dry silt, → Hard bottom
5. Send a copy of completed forms, page 1 and 2, to: Design Engineering, Mr. S. D. Hager, Chief Engineer, Attention: M. S. Silts.
6. Station to retain original and complete the next column at the next monitoring interval.

geotechnical, environmental & construction materials consultants

Coal Combustion Dam Inspection Checklist Form

US Environmental Protection Agency

Site Name:

Unit Name:

Unit I.D.:

Inspector's Name:

Date:

Operator's Name:

Hazard Potential Classification: High Significant Low

Check the appropriate box below. Provide comments when appropriate. If not applicable or not available, record "N/A". Any unusual conditions or construction practices that should be noted in the comments section. For large diked embankments, separate checklists may be used for different embankment areas. If separate forms are used, identify approximate area that the form applies to in comments.

	Yes	No		Yes	No
1. Frequency of Company's Dam Inspections?	Monthly Annually		18. Sloughing or bulging on slopes?		✓
2. Pool elevation (operator records)?	765		19. Major erosion or slope deterioration?		✓
3. Decant inlet elevation (operator records)?			20. Decant Pipes:		
4. Open channel spillway elevation (operator records)?			Is water entering inlet, but not exiting outlet?		✓
5. Lowest dam crest elevation (operator records)?	775		Is water exiting outlet, but not entering inlet?		✓
6. If instrumentation is present, are readings recorded (operator records)?	✓		Is water exiting outlet flowing clear?	✓	
7. Is the embankment currently under construction?		✓	21. Seepage (specify location, if seepage carries fines, and approximate seepage rate below):		
8. Foundation preparation (remove vegetation,stumps, topsoil in area where embankment fill will be placed)?	N/A		From underdrain?	✓	
9. Trees growing on embankment? (If so, indicate largest diameter below)		✓	At isolated points on embankment slopes?		✓
10. Cracks or scarps on crest?		✓	At natural hillside in the embankment area?		✓
11. Is there significant settlement along the crest?		✓	Over widespread areas?		✓
12. Are decant trashracks clear and in place?	✓		From downstream foundation area?	✓	
13. Depressions or sinkholes in tailings surface or whirlpool in the pool area?		✓	"Boils" beneath stream or ponded water?		✓
14. Clogged spillways, groin or diversion ditches?		✓	Around the outside of the decant pipe?		✓
15. Are spillway or ditch linings deteriorated?		✓	22. Surface movements in valley bottom or on hillside?		✓
16. Are outlets of decant or underdrains blocked?		✓	23. Water against downstream toe?	✓	
17. Cracks or scarps on slopes?		✓	24. Were Photos taken during the dam inspection?	✓	

Major adverse changes in these items could cause instability and should be reported for further evaluation. Adverse conditions noted in these items should normally be described (extent, location, volume, etc.) in the space below and on the back of this sheet.

Inspection Issue #

Comments

U. S. Environmental Protection Agency

Coal Combustion Waste (CCW)
Impoundment Inspection

Impoundment NPDES Permit # INSPECTOR
Date

Impoundment Name
Impoundment Company
EPA Region
State Agency (Field Office) Addresss

Name of Impoundment
(Report each impoundment on a separate form under the same Impoundment NPDES Permit number)

New Update

	Yes	No
Is impoundment currently under construction?		
Is water or ccw currently being pumped into the impoundment?		

IMPOUNDMENT FUNCTION:

Nearest Downstream Town : Name
Distance from the impoundment
Impoundment
Location: Longitude Degrees Minutes Seconds
Latitude Degrees Minutes Seconds
State County

Does a state agency regulate this impoundment? YES NO

If So Which State Agency?

HAZARD POTENTIAL (In the event the impoundment should fail, the following would occur):

LESS THAN LOW HAZARD POTENTIAL: Failure or misoperation of the dam results in no probable loss of human life or economic or environmental losses.

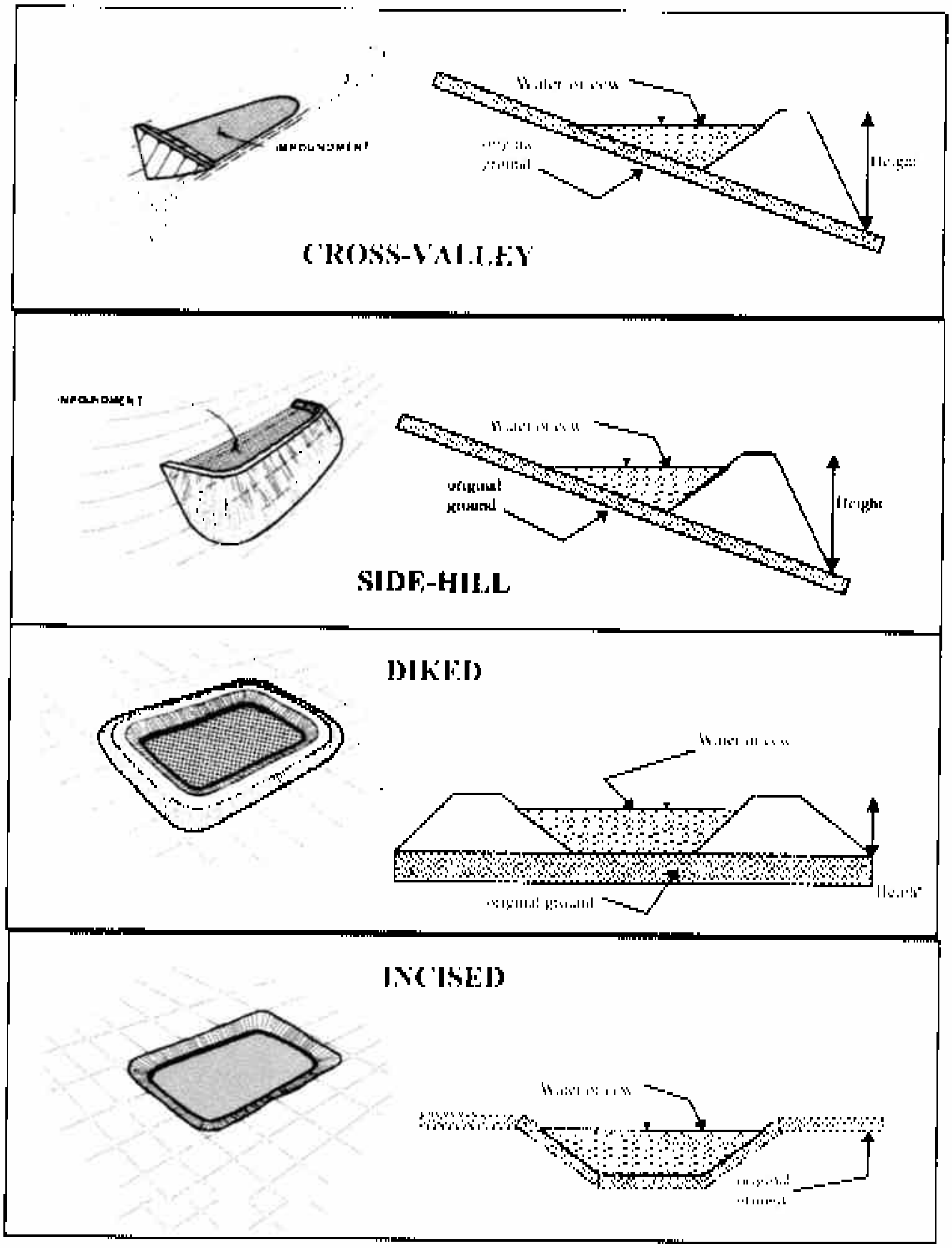
LOW HAZARD POTENTIAL: Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

SIGNIFICANT HAZARD POTENTIAL: Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

HIGH HAZARD POTENTIAL: Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

DESCRIBE REASONING FOR HAZARD RATING CHOSEN:

CONFIGURATION:



Cross-Valley
Side-Hill
Diked
Incised (form completion optional)
Combination Incised/Diked

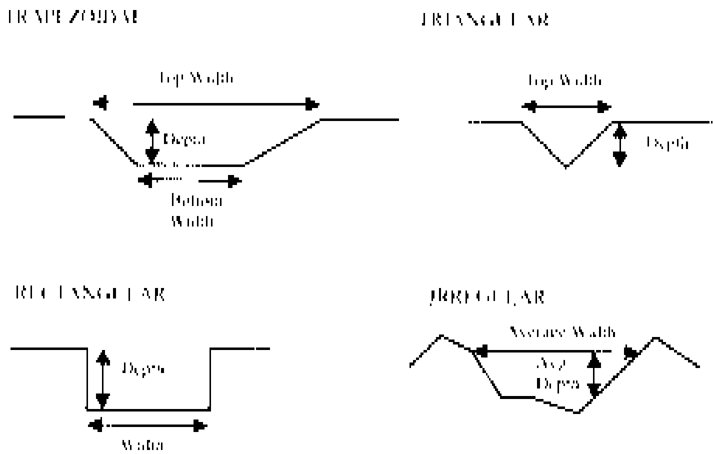
Embankment Height	feet	Embankment Material	
Pool Area	acres	Liner	
Current Freeboard	feet	Liner Permeability	

<u>TYPE OF OUTLET</u> (Mark all that apply)

Open Channel Spillway

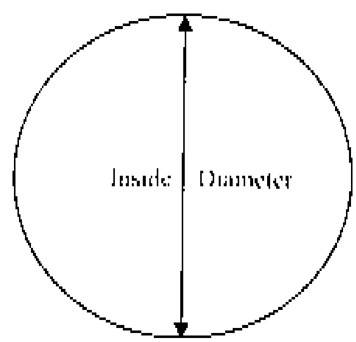
Trapezoidal
Triangular
Rectangular
Irregular

depth
bottom (or average) width
top width



Outlet

inside diameter



Material

corrugated metal
welded steel
concrete
plastic (hdpe, pvc, etc.)
other (specify)

Is water flowing through the outlet? YES NO

No Outlet

Other Type of Outlet (specify)

The Impoundment was Designed By

Has there ever been a failure at this site? YES NO

If So When?

If So Please Describe :

Has there ever been significant seepages at this site? YES NO

If So When?

IF So Please Describe:

Has there ever been any measures undertaken to monitor/lower Phreatic water table levels based on past seepages or breaches at this site? YES NO

If so, which method (e.g., piezometers, gw pumping,...)?

If so Please Describe :